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GEOLOGY REPORT

AREA 3 RADIOACTIVE WASTE MANAGEMENT SITE DOE/NEVADA TEST SITE, NYE COUNTY, NEVADA

Prepared By

Environmental Management
National Security Technologies[LLC]
Las Vegas, Nevada

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Abstract

Surficial geologic studies near the Area 3 Radioactive Waste Management Site (RWMS) were conducted as part of a site characterization program. Studies included evaluation of the potential for future volcanism and Area 3 fault activity that could impact waste disposal operations at the Area 3 RWMS.

Future volcanic activity could lead to disruption of the Area 3 RWMS. Local and regional studies of volcanic risk indicate that major changes in regional volcanic activity within the next 1,000 years are not likely. Mapped basalts of Paiute Ridge, Nye Canyon, and nearby Scarp Canyon are Miocene in age. There is a lack of evidence for post-Miocene volcanism in the subsurface of Yucca Flat, and the hazard of basaltic volcanism at the Area 3 RWMS, within the 1,000-year regulatory period, is very low and not a forseeable future event.

Studies included a literature review and data analysis to evaluate unclassified published and unpublished information regarding the Area 3 and East Branch Area 3 faults mapped in Area 3 and southern Area 7. Two trenches were excavated along the Area 3 fault to search for evidence of near-surface movement prior to nuclear testing. Allostratigraphic units and fractures were mapped in Trenches ST02 and ST03.

The Area 3 fault is a plane of weakness that has undergone strain resulting from stress imposed by natural events and underground nuclear testing. No major vertical displacement on the Area 3 fault since the Early Holocene, and probably since the Middle Pleistocene, can be demonstrated. The lack of major displacement within this time frame and minimal vertical extent of minor fractures suggest that waste disposal operations at the Area 3 RWMS will not be impacted substantially by the Area 3 fault, within the regulatory compliance period.

A geomorphic surface map of Yucca Flat utilizes the recent geomorphology and soil characterization work done in adjacent northern Frenchman Flat. The approach taken was to adopt the map unit boundaries (line work) of Swadley and Hoover (1990) and re-label these with map unit designations like those in northern Frenchman Flat (Huckins-Gang et al, 1995a,b,c; Snyder et al, 1995a,b,c,d).

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Preface

Surficial geologic studies near the Area 3 Radioactive Waste Management Site (RWMS) were conducted in Fiscal Years 1996 and 1997 as part of a site characterization program designed to satisfy the data needs of (1) the Low-Level Waste Performance Assessment required by U.S. Department of Energy (DOE) Order 5820.2A, *Radioactive Waste Management* (DOE, 1988)[1] (now superseded by DOE O 435.1, *Radioactive Waste Management* [DOE 1999]; (2) the Low-Level Waste Composite Analysis required at DOE sites (DOE, 1996) in response to Recommendation 94-2 of the Defense Nuclear Facility Safety Board; and, (3) Resource Conservation and Recovery Act closure requirements pursuant to 40 Code of Federal Regulations 265.

A document entitled "Geology Report: Area 3 Radioactive Waste Management Site, DOE/Nevada Test Site, Nye County, Nevada" was prepared by Bechtel Nevada (BN) in January 1998 but was was never submitted for public release. This document supersedes the 1998 report.

As part of National Security Technologies[LLC] (NSTec)'s current scope for closure planning for the Area 3 RWMS, this report has been updated to conform to the current editorial standards of NSTec and the DOE National Nuclear Security Administration Nevada Site Office. This document is being submitted for approval for public release so it will be accessible for public review and for citation in future documents.

[1] Superseded by DOE O 435.1 "Radioactive Waste Management" (DOE 1999).

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Executive Summary

This report presents a summary of geologic studies undertaken by Bechtel Nevada during calendar year 1996 and fiscal year 1997 near the Area 3 Radioactive Waste Management Site (RWMS) at the U.S. Department of Energy (DOE) Nevada Test Site, Nye County, in southern Nevada.

Surficial geologic studies near the Area 3 RWMS were conducted as part of a site characterization program designed to satisfy the data needs of:

1. The Low-Level Waste Performance Assessment required by DOE Order 5820.2A, Radioactive Waste Management (DOE, 1988) (now superseded by DOE O 435.1, Radioactive Waste Management [DOE 1999];
2. The Low-Level Waste Composite Analysis required at DOE sites (DOE, 1996) in response to Recommendation 94-2 of the Defense Nuclear Facility Safety Board; and
3. The Resource Conservation and Recovery Act closure requirements in response to 40 Code of Federal Regulations 265.

Studies included evaluation of the potential for any future volcanism and activity of the Area 3 fault that would impact waste disposal operations at the Area 3 RWMS adversely.

Future volcanic activity is one potential scenario that could lead to disruption of the Area 3 RWMS. Local and regional studies of volcanic risk (Conner and Hill, 1995; Crowe et al, 1995; and Geomatrix Consultants, Inc., 1996) indicate that major changes in regional volcanic activity within the next 1,000 years are not likely. Based on the Miocene ages of the basalt of Paiute Ridge, Nye Canyon, and nearby Scarp Canyon, and the lack of evidence for post-Miocene volcanism in the subsurface of Yucca Flat, the hazard of basaltic volcanism at the Area 3 RWMS within the 1,000-year regulatory period is very low and not a forseeable future event.

A literature review and data analysis were undertaken to evaluate unclassified published and unpublished information about the Area 3 and East Branch Area 3 faults mapped in Area 3 and southern Area 7. Two trenches were excavated along the Area 3 fault to search for evidence of near-surface movement prior to nuclear testing. Allostratigraphic units and fractures, were mapped in Trenches ST02 and ST03.

The Area 3 fault is a plane of weakness that has undergone strain resulting from stress imposed by natural events, and more recently, by underground nuclear testing. No major vertical displacement on the Area 3 fault since the Early Holocene, and probably since the Middle Pleistocene, can be demonstrated by the continuity of alloformations in both Trenches ST02 and ST03. The lack of major displacement within this time frame, and minimal vertical extent of minor fractures, suggest that waste disposal operations at the Area 3 RWMS will not be substantially impacted by the Area 3 fault within the regulatory compliance period.

A geomorphic surface map was made of Yucca Flat that utilizes the recent geomorphology and soil characterization work done in adjacent northern Frenchman Flat (Plate 3). The approach taken was to adopt the map unit boundaries (line work) of Swadley and Hoover (1990) and relabel these with map unit designations like those in northern Frenchman Flat (Huckins-Gang et al, 1995a,b,c; Snyder et al, 1995a,b,c,d).

Description and analyses of soils in three trenches and across the landscape of Yucca Flat was integral to understanding the surficial geology in the vicinity of the Area 3 RWMS. Soil profile descriptions and characterization data were integral in establishing the allostratigraphy in the soil trenches.

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Acronyms and Abbreviations

BN	Bechtel Nevada
C	Celsius
CFVZ	Crater Flat Volcanic Zone
CFR	Code of Federal Regulations
cm	centimeter
DOE	U. S. Department of Energy
F	Fahrenheit
FEMA	Federal Emergency Management Agency
ft	foot, feet
FY	fiscal year
hr	hour
in.	inches/inch
ka	thousand years ago
km	kilometer, kilometers
km^2	square kilometers
kt	kilotons
LLW	low level waste
Ma	million years ago
m	meters
mi	mile, miles
mi^2	square miles
mm	millimeter(s)
NIST	National Institute of Standards and Technology
NSTec	National Security Technologies^{LLC}
NTS	Nevada Test Site
OSL	optically stimulated luminescence
RCRA	Resource Conservation and Recovery Act
RWMS	Radioactive Waste Management Site
USGS	United States Geological Survey
YPB	younger post-caldera basalt
$^{\circ}$	degree, degrees

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1.0 INTRODUCTION

This report presents a summary of geologic studies undertaken by Bechtel Nevada during calendar year 1996 and fiscal year (FY) 1997 near the Area 3 Radioactive Waste Management Site (RWMS) at the U.S. Department of Energy (DOE) Nevada Test Site (NTS), Nye County, in southern Nevada. The Area 3 RWMS covers approximately 20 hectare 50 acre with three disposal cells located within the facility boundary. Two of the waste-management cells each consist of two collapse sinks (craters) that have been joined to make one large, oval-shaped landfill cell. The third cell is a single collapse sink (Figure 1). Disposal cell U-3ax/bl has been operationally closed under Resource Conservation and Recovery Act (RCRA) Interim Status. Disposal cell U-3ah/at continues to receive bulk low-level waste (LLW) that is disposed using conventional landfill techniques. Disposal cell U 3bh has received only uncontainerized plutonium-contaminated soil from DOE Nevada environmental restoration projects. In addition, there are two sinks within the facility boundary that have not been used.

1.1 Purpose

Surficial geologic studies near the Area 3 RWMS were conducted as part of a site characterization program designed to satisfy the data needs of:

1. The LLW Performance Assessment required by DOE Order 5820.2A, Radioactive Waste Management (DOE, 1988);
2. The LLW Composite Analysis required at DOE sites (DOE, 1996) in response to Recommendation 94-2 of the Defense Nuclear Facility Safety Board; and
3. The RCRA closure requirements in response to 40 Code of Federal Regulations (CFR) 265.

1.2 Location and Setting

The Area 3 RWMS is located in Yucca Flat, within the northeast quadrant of the NTS (Figure 1). The Yucca Flat watershed is a structurally closed basin encompassing an area of approximately 300 square miles (mi^2) (780 square kilometers [km^2]). The ground surface within Yucca Flat slopes primarily from north to south toward Yucca Lake. The surface slope is approximately 1 percent at the Area 3 RWMS.

Yucca Flat is bound to the north by Quartzite Ridge and Rainier Mesa, to the east by the Halfpint Range, to the south by the Massachusetts Mountains and Control Point Hills, and to the west by Mine Mountain and the Eleana Range. The surrounding mountains consist primarily of Paleozoic sedimentary and Tertiary volcanic rocks. The generalized stratigraphic section of the basin is Quaternary and Tertiary alluvium over Tertiary rocks that, in turn, overlie Paleozoic rocks. The major structural features of the basin are north-south trending faults, including the Carpetbag fault, Yucca fault, and associated splays (Frizzel and Shulters, 1990).

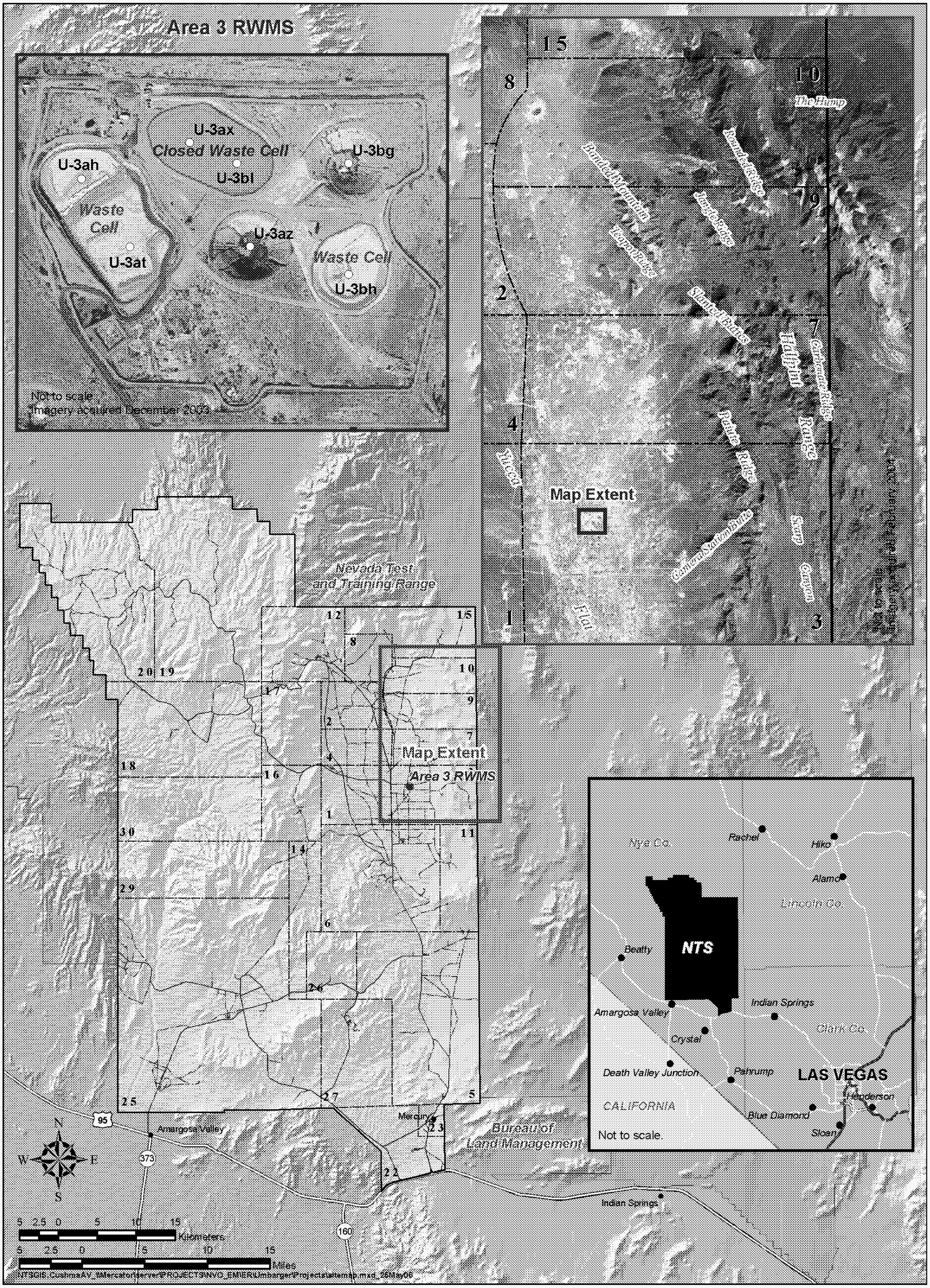

Figure 1. Location map and physiographic features of the Nevada Test Site and the Area 3 RWMS.

Climate at the NTS is characterized by low precipitation, a large diurnal temperature range, low humidity, high evaporation rates, and moderate to high winds. Annual precipitation at lower elevations, such as Yucca Flat (3,920 ft [1,195 meters (m)]), averages 6 inches (in.) (150 millimeters [mm]). The Area 3 RWMS is located at an elevation of 4,020 ft. (1,225 m). Average daily maximum and minimum temperatures at Yucca Flat are 51E Fahrenheit (F) and 21EF (11E Celsius [C] and -6EC) in January and 96EF and 57EF (36EC and 14EC) in July (DOE, 1995). Average relative humidity at the Area 3 RWMS during 1996 ranged from 47 percent in February to 14 percent in June (D. G. Levitt, Personal Communication, 1996). Annual potential evaporation is approximately ten times greater than annual precipitation (French, 1993). Average annual wind speed in Yucca Flat is 7 miles (mi)/hour (hr) (11 kilometers [km]/hr) (Quiring, 1968). The prevailing wind direction during the winter is north-northwesterly, and during the summer, it is south-southwesterly.

The two major vegetation types within Yucca Flat are the Coleogyne and Grayia-Lycium Associations. A major species in the Coleogyne Association is *Coleogyne ramosissima* (blackbrush). Major species in the Grayia-Lycium Association, which predominates, are *Grayia spinosa* (hopsage) and *Lycium andersonii* (desert thorn).

1.3 Related Documents

Site characterization studies at the Area 3 RWMS related to the surficial geology studies summarized in this report are presented in several other documents. These documents are briefly summarized below.

1.3.1 Flood Assessment

A flood assessment was conducted at the Area 3 RWMS (Miller, 1996). This study was conducted to determine whether the Area 3 RWMS was located within a 100-yr flood hazard, as defined by the Federal Emergency Management Agency (FEMA), and to provide both 100- and 500-yr discharges for design of flood protection. The study area encompassed the approximately 300-mi^2 (780-km^2) watershed of Yucca Flat, but focused on an approximately 36-mi^2 (94-km^2) drainage area that could impact the Area 3 RWMS directly. The flood assessment determined that the Area 3 RWMS is not located within a FEMA-designated 100-yr. 6-hr flood hazard zone.

1.3.2 Area 3 Soil Characterization Database

A document was compiled that presents the database of a soil characterization study conducted at the Area 3 RWMS (Van Remortel et al, 1997). The database is maintained in a Microsoft® Excel© Version 5.0 for Windows™ spreadsheet that can be transferred into other spreadsheet or database formats. Column fields include both descriptive field data and analytical laboratory data. Methods used to produce the analytical laboratory data are described in Snyder and others (1996). Quality assurance criteria used to evaluate the quality of the data are described in Byers and others (1996).

1.3.3 Area 3 Hydrogeologic Characterization Borehole Reports

Four data reports were compiled that contain detailed characterization of the hydrogeologic properties and processes of the alluvium at the Area 3 RWMS (Schmeltzer et al, 1996; Bechtel Nevada, 1998a,b,c). These reports were compiled from data collected through drilling and sampling of seven boreholes at the Area 3 RWMS. Core segments from the boreholes were used for measurement of the current moisture status; laboratory analyses for physical and hydraulic characteristics; and measurement of chloride, tritium, and stable isotope concentrations.

1.3.4 Other Studies

Later studies conducted to characterize the site of the Area 3 RWMS include the *Characterization Report for Corrective Action Unit 110: Area 3 U-3ax/bl disposal Unit Nevada Test Site, Nevada* (DOE/NV—580, BN 1999); the *Site Characterization Data from the U3-ax/bl Exploratory Boreholes at the Nevada Test Site* (DOE/NV/11718—003-REV.1, BN 2005b); and *Potential Groundwater Recharge and the Effects of Soil Heterogeneity on Flow at Two Radioactive Waste Management Sites at the Nevada Test Site* (DOE/NV/11718—609; Levitt and Yucel, 2002). These studies, along with this report, provided data that were used in the creation of a new, hydrostratigraphic model to be used for a better understanding of the groundwater flow and contaminant transport properties of the area.

1.3.5 Hydrostratigraphic Model and Alternatives for Groundwater Flow and Contaminant Transport Model of Corrective Action Unit 97: Yucca Flat-Climax Mine, Lincoln and Nye Counties, Nevada

In January 2006, a Phase I, 3-dimensional hydrostratigraphic framework model was constructed for the Yucca Flat-Climax Mine area of the NTS. The model will be used to develop groundwater flow and contaminant transport models for the underground nuclear testing areas in this area. The model encompassed a buffer surrounding the corrective action unit that includes important rock outcrop and drill-hole control that help constrain geologic interpretations, including Area 3.

2.0 VOLCANISM

Future volcanic activity is one potential scenario that could lead to disruption of the Area 3 RWMS. There has been no volcanic activity near the Area 3 RWMS since the late-Miocene. However, multiple Quaternary volcanic centers are present near Yucca Mountain, located approximately 26 mi (42 km) southwest of the Area 3 RWMS (Figure 2) (Crowe et al, 1998). Extensive investigations have been conducted by the Yucca Mountain Project for over a decade to assess the probability and consequences of future volcanic activity for the Yucca Mountain site. While these analyses have been designed to be specific to the Yucca Mountain area, the results can be used indirectly to bound the probability of future volcanic activity at the Area 3 RWMS. In addition, volcanic rock samples collected and analyzed (B. D. Turrin, D. E. Champion, and D. L. Gustafson, unpublished data) as part of the Area 5 RWMS Greater Confinement Disposal Performance Assessment were also used in this study.

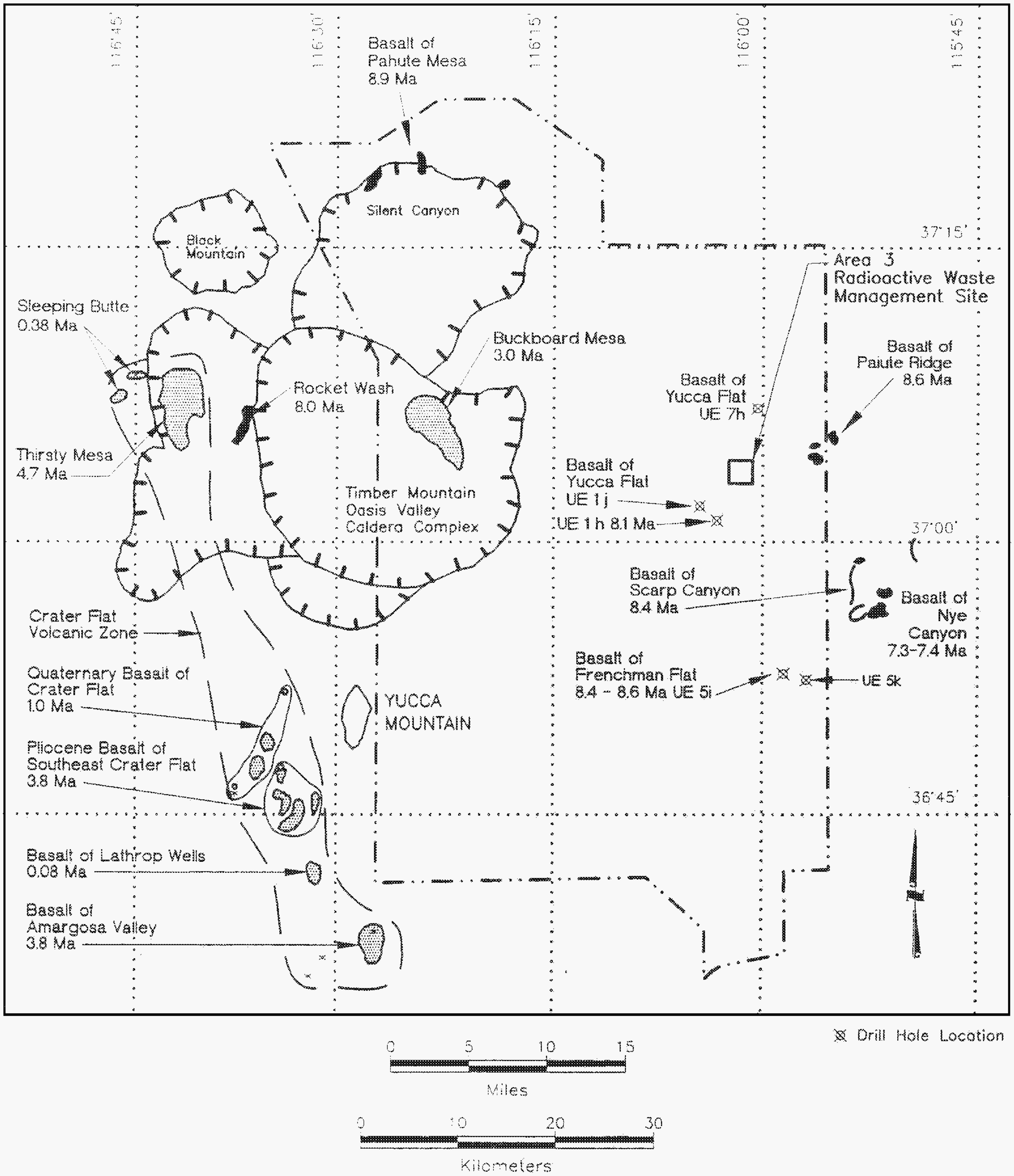

Figure 2-1. Post-caldera basalt of the Nevada Test Site region. Shaded areas are the Older Post-Caldera Basalt. Stippled areas are the Younger Post-Caldera Basalt. Asterisks mark aeromagnetic anomalies identified as potential buried basalt centers or intrusions. Ages estimated in millions of years. Modified from Crowe et al, 1998.

The two aspects to assess the risk of volcanism in the NTS region are, future silicic volcanic activity, and future basaltic volcanic activity. Hazards of silicic volcanism are negligible for several reasons (Crowe et al, 1983):

- Quaternary silicic volcanism is restricted to the eastern and western margins of the Great Basin.
- Silicic volcanism has been absent in the NTS region for the last 8.5 million years.
- Within the last 10 to 20 million years, there has been a dramatic decrease and, in most areas, a cessation of silicic volcanism within the central and southern parts of the Great Basin.

There are no Pliocene or younger silicic volcanic centers within a 31-mi (50-km) radius of the Area 3 RWMS. No site-specific data at or near Yucca Flat have been found in the literature or through field investigations that would alter the above interpretation of silicic volcanism near the Area 3 RWMS.

A transition from predominantly silicic volcanism to predominantly basaltic volcanism occurred approximately 10 million years ago (Ma) (Christiansen and Lipman, 1972). The probability of magmatic disruption of the Yucca Mountain site has been studied by multiple organizations. The mean probability estimates are 1.8 x 10-8 events yr-1 (Crowe et al, 1995), 1.5 x 10-8 events yr-1 (Geomatrix Consultants, Inc., 1996), and 1 x 10^{-8} to 5 x 10^{-8} events yr^{-1} (Connor and Hill, 1995). These probability estimates can be applied to the Area 3 RWMS using the following assumptions:

- The areas of maximum hazards of basaltic volcanism are in spatial and structural zones of Pliocene and Quaternary basaltic volcanism (Crowe et al, 1998). The Area 3 RWMS is located outside of all these spatial and structural volcanic zones.
- The background probability of magmatic disruption of areas outside of the Pliocene and Quaternary volcanic zones is less than about 3 x 10^{-9} events yr^{-1} (Crowe et al, 1998). Thus, the probability of magmatic disruption of the Area 3 RWMS is less than 3 x 10^{-9} events yr^{-1}.

Field investigations and drillhole studies suggest that shallow basalt intrusions are rare in the geologic record of the southern Great Basin (Crowe et al, 1986). Based on the analysis of previous basaltic volcanism in the NTS region, there is no evidence of evolution toward either an increase in the volcanic rate or the development of a large-volume volcanic field (Crowe et al, 1986).

The nearest basalt exposed at the land surface to the Area 3 RWMS is the Paiute Ridge basalt, approximately 4 mi (6 km) to the northeast (Figure 2). The Paiute Ridge basalt consists of a complex network of mafic dikes, sills, and lopoliths (Ratcliff et al, 1994). This post-caldera basalt erupted approximately 8.6 Ma (Ratcliff et al, 1994).

In Yucca Flat, basalts were found in three drill holes: UE1h, UE1j, and UE7h (Figure 2). The depth of these basalts are:

- 740 to 1,010 ft (226 to 308 m) in UE1h
- 1,360 to 1,400 ft (415 to 427 m) in UE1j
- 2,440 to 2,510 ft (744 to 765 m) in UE7h

Potassium-argon analysis yielded a numerical age of 8.1 ∀ 0.6 Ma for the basalt encountered in drill hole UE1h (Marvin et al, 1989). No ages are available for the basalts in UE1j and UE7h.

There was a regional hiatus in volcanic activity after eruption of the basalt of Nye Canyon, located approximately 12 mi (19 km) southeast of the Area 3 RWMS, with a numerical age of about 7.3 Ma (B. D. Turrin, D. E. Champion, and D. L. Gustafson, unpublished data). No volcanic rocks of the NTS region have yielded numerical ages in the range of 7.3 to 4.7 Ma (Figure 2) (Crowe et al, 1998). The younger post-caldera basalt (YPB) includes all volcanic rocks younger than the basalt of Nye Canyon (Crowe, 1990). The nearest Quaternary basalt to the Area 3 RWMS is that of Crater Flat, approximately 32 mi (51 km) southwest of the Area 3 RWMS, with numerical ages of about 1.0 Ma (Figure 2) (Crowe et al, 1998).

Crowe and Perry (1989) defined a narrow northwest-trending zone called the Crater Flat Volcanic Zone (CFVZ) that encompasses all the YPB centers, with the exception of the basalt of Buckboard Mesa (Figure 2). Crowe (1990) concluded the formation of a new volcanic center or cluster of centers has a finite probability of occurring at the NTS, with the most likely area of formation being in the CFVZ. The Area 3 RWMS is located outside of the CFVZ.

Local and regional studies of volcanic risk (Conner and Hill, 1995; Crowe et al, 1995; and Geomatrix Consultants, Inc., 1996) indicate that major changes in regional volcanic activity within the next 1,000 yrs are not likely. Based on the Miocene ages of the basalt of Paiute Ridge, Nye Canyon, and nearby Scarp Canyon, and the lack of evidence for post-Miocene volcanism in the subsurface of Yucca Flat, the hazard of basaltic volcanism at the Area 3 RWMS within the 1,000-yr regulatory period is very low and not a forseeable future event.

3.0 STRUCTURE

3.1 Regional

The structure and geomorphology of Yucca Flat is typical of intermontane basins occurring throughout the Basin and Range Province of Nevada and adjoining states. Faulted and tilted blocks of Tertiary volcanic rocks and underlying Paleozoic sedimentary rocks form low ranges on both sides of the basins. These ranges bound rotated and downdropped blocks in the basins. Erosion of the ranges over several millions of years has resulted in the deposition of a significant thickness of alluvium within the basin. The topography of the prealluvial surface and ongoing structural activity during alluvial deposition influence the present alluvium thicknesses. Mid-basin alluvium thickness in southern Yucca Flat, for example, generally ranges from 100 to 2,300 ft (30 to 700 m) (Drellack, 1994a).

The tectonic history, and thus present geometry, of rocks at the NTS is very complex. The pre-Tertiary rocks were significantly deformed in Late Mesozoic time (the Sevier Orogeny). In western Yucca Flat and CP Hills, portions of the Paleozoic section are repeated as a result of Mesozoic thrust faulting. Thrust faults identified in the NTS vicinity include the Mine Mountain and CP thrusts in the Yucca Flat area, the Specter Range thrust west of Mercury, and the Spotted Range thrust east of Mercury. Most plates were transported eastward with displacements on the order of 10s of kilometers (Orkild, 1983). In Miocene to Quaternary times, these Paleozoic rocks and the overlying volcanic units were disrupted by large-scale extensional block faulting that is largely responsible for the present Basin and Range topography.

The resultant structural setting of Yucca Flat is best shown in a west-east cross section (Plate 1). Fault locations are based primarily on drill hole data (Drellack and Thompson, 1990), as well as derivative isopach and structure contour maps (Drellack, 1995a). Geophysical data (i.e., gravity, seismic, and magnetic) were used, especially where drillhole data are sparse. Some faults can be projected to the surface and correlated with the trends of cracks on a postshot surface effects compilation map (U.S. Geological Survey [USGS], unpublished map, 1:12,000 scale). Many of these "younger" faults (e.g., the Yucca fault) displace younger features such as the top of zeolitization (Drellack, 1995b) or internal bedding within the deeper alluvium (Elwood et al, 1985). Other faults, considered "older," are not readily discernable on either surface effects maps or the top of zeolitization contour maps.

Most of the displacement on these faults is dip-slip; however, a right-lateral, strike-slip component of motion also has been documented (Ferguson, 1981). Vertical displacements on these normal faults ranges from approximately 2,000 ft (610 m) on the main basin-forming faults to less than 50 ft (15 m) on the lesser faults. Unless other information is available, the high-angle normal faults are assumed to have a true dip of about 70 degrees (°).

There is evidence that Basin and Range crustal extension occurred in at least two stages across the NTS. The early phase, about 16 to 14 Ma, consisted of high-angle northwest- and northeast-trending normal (including detachment) faults, whereas the later phase, younger than 11 Ma, consisted of slightly steeper dipping north-south trending normal faults. The earlier phase is thought to be responsible for several minor topographical troughs discernable on isopach maps of older ash-flow units and for the recently reinterpreted low-angle faults in the Mine Mountain area (Cole et al, 1989). The later phase is responsible for the present basin-forming faults (Dockery-Ander, 1984).

Displacement of the Paleozoic rocks by high-angle Tertiary faults is assumed to be about the same as that of the overlying volcanic section. In parts of Yucca Flat, downhole photography reveals steepening of bed dips with depth, indicating intermittent displacement over time.

The principal basin-forming faults in Yucca Flat are the Yucca fault and the Carpetbag fault, both east-dipping, moderately high-angle normal faults. The Yucca fault is located in the east-central portion of the basin. It trends north-south and extends the entire length of the valley. The Carpetbag fault also strikes north-south and is located in the western part of the valley. Toward the south, the Carpetbag fault steps eastward in an en echelon fashion to become the Topgallant fault. The Carpetbag fault represents the eastern side of a large north-south trending buried horst of Paleozoic carbonate rocks (also referred to as the "Gravity High"). This horst separates the large main basin on the east from several smaller subbasins on the west.

Age estimates for these youngest faults has been the focus of several studies (Knauss, 1981; Shroba et al, 1988). Knauss (1981) brackets the age of the last natural movement along the Carpetbag fault between 37 and 93 thousand years ago (ka), and along the Yucca fault at less than 35 ka. Shroba and others (1988) conclude that no significant natural vertical surface displacement has occurred along the Carpetbag system during the past 125,000 to 350,000 years.

The nearest known fault to the Area 3 RWMS passes through the eastern margin of the facility and is called the Area 3 fault. The projected surface trace of this fault is assumed to follow a minor, but persistent, trend of postshot surface fractures. Available information suggests that the Area 3 RWMS is located on a structural block that is bounded on the east by the west-dipping Area 3 fault and on the west by the east-dipping Yucca fault (Plate 1).

3.2 The Area 3 and East Branch Area 3 Faults

3.2.1 Literature Review

A literature review and data analysis were undertaken to evaluate unclassified published and unpublished information regarding the Area 3 and East Branch Area 3 faults mapped in Area 3 and southern Area 7. This work focused on determining how, and by who, the surface traces of the Area 3 fault and East Branch Area 3 fault were recognized; and whether geophysical and borehole data corroborate the surface expression of these mapped features. The annotated bibliography (Appendix A) is summarized in this section.

The Area 3 fault was first mapped and named by Williams and others in 1963 (Appendix A, Entry 7) as a zone of surface fractures caused by the BILBY (U3cn) and BANDICOOT (U3bj) tests (Plate 2). Some fractures had up to 6 in. (15 centimeters ([cm]) of vertical offset. The predominant sense of motion was to the west. (The term "fractures," as used during post-event mapping, included features with scarps and without scarps.) Surface mapping associated with subsequent tests added more fractures, extending the Area 3 fault trace farther northward. The USGS compilation map of surface effects (USGS, unpublished map, 1:12,000 scale; Appendix A, Entry 41) presents the most current representation of the Area 3 fault surface expression.

Not all test-induced fractures, even if observed, are shown on compilation maps, which represent the intermittent nature of post-event mapping.

Mapping of surface effects was first completed for the BANDICOOT test in September 1962 (Emerick, 1963; Appendix A, Entry 2) and became routine for tests from January 1964 through June 1966. After June 1966, surface effects were only mapped following select tests. For the section near the Area 3 fault, no published compilation maps or individual test maps were found for the period from April 1967 through October 1969, or from December 1975 to the present. A consequence of intermittent mapping is that some fractures may not be shown on any map. Notably, no surface effects were mapped in association with any tests within the boundaries of the Area 3 RWMS because these tests pre-date routine mapping of surface effects. For example, the RINGTAIL test (U3ak) in December 1961 resulted in a recognized zone of aligned fractures that were not mapped (Emerick, 1963; Appendix A, Entry 2).

Aerial photographs of Yucca Flat taken in 1951, prior to nuclear testing at the NTS, were studied by Morris (1965; Appendix A, Entry 19) to "determine the geological nature of the lineaments and whether they have any special or casual relation to explosion-produced fractures." The study revealed a 2,500-ft- (760-m)-long lineament east of emplacement hole U7b, near the northern end of the Area 3 fault, and a 12,000-ft- (3,660-m)-long curving lineament east of the Area 3 fault. When Morris transferred these lineaments to the then-current surface-effects map (Emerick et al, 1965; Appendix A, Entry 17), the result was the first hint of a wishbone-shaped fault system in Area 3 and southern Area 7. This was a north-south trace defined by testing-induced fractures and a pretesting lineament at the north end, and a curved east branch based on a pretesting lineament that was cracked along its entire length by nuclear testing (R. H. Morris, Personal Communication., 1996). In addition, weathered (presumably natural) scarps in Pleistocene alluvium were found along the Area 3 fault trace by Dickey (1968; Appendix A, Entry 29). In 1972, Snyder and Rogers (Appendix A, Entry 33) shortened Morris' curved, cracked lineament when they transferred it to their surface-effects map. They named this shortened lineament the "East Branch Area 3 fault."

National Geophysical Company (formerly Namco International, Inc.) conducted seismic surveys during the 1960s near the Area 3 RWMS (Appendix A, Entries 1, 4, 9, and 15). These seismic surveys are the source of the geophysically inferred faults shown on early surface-effects maps (Davis, 1964; Emerick and Davis, 1965; Morris, 1965; Corchary, 1966a,b; McKeown and Dickey, 1967; Appendix A, Entries 10, 17, 19, 23, 24, and 25, respectively). Faults mapped by National Geophysical Company are all interpreted as east-dipping normal faults, including a fault parallel to part of the Area 3 fault. The east-dipping normal fault interpretations are not supported by subsurface control. A comparison of drillhole data with structure contour maps from National Geophysical Company reports shows numerous inconsistencies. For example, reflectors mapped by National Geophysical Company show offset of 250 ft (76 m) on the Yucca fault, whereas drillhole data near the seismic surveys show the offset to be approximately 1,500 ft (460 m). These inconsistencies can be explained by incorrect velocities used to produce the structure maps, the poor quality of the seismic records, or a combination of both. Although cited by previous workers as evidence of the subsurface location of the Area 3 fault, this review of the National Geophysical Company data does not provide such conclusive geophysical evidence. Ferguson (1981; Appendix A, Entry 37) recorded a seismic line approximately 6,340 ft (1,930 m) south of the Area 3 RWMS. West-dipping normal faults are interpreted at the top of the Paleozoic section and within the Tertiary section near the southern projections of the Area 3 and East Branch Area 3 faults. However, no reflector provides evidence that these faults extend through the Quaternary alluvium to the surface.

Gravity studies by Healey (1963) and Hazelwood and others (1963) (Appendix A, Entries 5 and 6, respectively) recorded a gravity high and low at the north end of the Area 3 fault. One interpretation is that the gravity high and low may be on the west and east sides, respectively, of the northern projection of the fault. Thus, the gravity low would represent a block of pre-Cenozoic rocks downdropped to the east relative to the adjacent rocks to the west (the gravity high). Alternatively, the gravity high and low could result from a mechanism not related to faulting; for example, paleotopography or differing lithologies. Although numerous, closely spaced faults have been mapped within the Tertiary section in this area (Drellack, 1994; Appendix A, Entry 40), no Cenozoic high is apparent from drill hole data.

Detailed subsurface characterization near the Area 3 fault is precluded by a paucity of deep drillholes in that area. However, two drill holes, U3cs and U3kx, which are approximately 1,000 ft (300 m) apart and on opposite sides of the Area 3 fault (Plate 2), show the top of the Rainier Mesa Tuff to be at an elevation of 3,183 and 2,900 ft (970 and 880 m), respectively (Drellack, 1994b; Appendix A, Entry 40). Although the difference in elevation of 287 ft (90 m) can be interpreted as faulting down to the west, a second interpretation is a subsurface dip at the top of the Rainier Mesa Tuff of 16° west along a line between the two drillholes. Tertiary rocks that crop out approximately 2 mi (3 km) to the east of the drill holes dip at 5° to 15° west.

Two trenches were dug across the surface trace of the Area 3 fault by the USGS in 1965. These were mapped by Carr (1965; Appendix A, Entry 16), who noted fracturing, but did not observe a distinct fault in either. Trench D was approximately 10 ft (3 m) deep and crossed the northern part of the Area 3 fault 500 ft (152 m) southwest of U7b. Trench E was 5 to 10 ft (1.5 to 3 m) deep and crossed the southern part of the fault 200 ft (60 m) north of the U3bj collapse sink.

Whether the surface scarps and cracking were a result of subsurface movement on the Area 3 fault or differential compaction of alluvium over a subsurface scarp has been controversial and remains unresolved (S. L. Drellack, Jr., Personal Communication, 1995; App, 1985; Appendix A, Entry 39). Dickey (1968; Appendix A, Entry 29) conducted a survey along the Yucca fault prior to and after an underground nuclear test. The results of the survey indicated that bedrock was displaced and that the observed surface effects were not merely the result of differential compaction of the alluvium.

3.2.2 Current Surface Expression

Most test-induced fractures were short-lived features and are no longer evident on the landscape. However, three scarps that pre-date testing were observed in the field (Plate 2). One scarp along the Area 3 fault is immediately north of the intersection of the Area 3 fault and the East Branch Area 3 fault. Here, for approximately 600 ft (183 m), a Late Pleistocene or early Holocene surface is offset about 2 ft (0.6 m). This may be one of the "weathered west-facing scarp[s] about 2 ft high" that Dickey (1968; Appendix A, Entry 29) reported. At this location in 1970, a 4-in- (10-cm)-high scarp was mapped as an effect of the TIJERAS test at U7y (E. C. Jenkins, oral comm., 1996). It is not discernable what part of the old scarp was reactivated.

The second scarp found along the Area 3 fault is approximately 1,500 ft (457 m) northeast of drill hole U3cq, in a remnant of a Late Pleistocene or early Holocene surface. The scarp is much less than 1 ft (0.3 m) high, little more than a small break in slope. Presumably, the scarp pre-dates nuclear testing because no testing-induced fractures with offset were mapped in this area, and the fan surface is undisturbed by human activity. In addition, the long axis of this ancient fan remnant is bound by drainages oriented subparallel to the zone of testing-induced fractures (without offset) mapped after the BILBY and CANVASBACK tests (Williams, 1964a,b; Appendix A, Entries 8 and 11).

The scarp along the East Branch Area 3 fault is about 4,500 ft (1,370 m) south of its intersection with the Area 3 fault. This scarp is approximately 3 ft (1 m) high and offsets a Middle Pleistocene surface. Surface features (such as desert varnish and pavement) and near-surface soil horizons are continuous across the scarp, indicating the scarp is older than these features.

The USGS trenches excavated and mapped by Carr (1965; Appendix A, Entry 16) were not reviewed because the trenches were caved, or within an inaccessible area, or both.

4.0 SUBSURFACE INVESTIGATIONS

Subsurface investigations comprised stratigraphic and fracture analyses. The stratigraphic analysis consisted of mapping allostratigraphic units and lithofacies. The fracture analysis consisted of locating and tracing fractures and fracture zones, and identifying any offset of adjacent strata.

4.1 Stratigraphy

Two trenches were excavated along the Area 3 fault to search for evidence of near-surface movement prior to nuclear testing. Both trenches were excavated to a depth of 10 ft (3 m) with a bench on each side at 5 ft (1.5 m) below the ground surface. One trench, ST02, was dug across the scarp found closest to the Area 3 RWMS, which is the small slope break (and associated drainageways) near drill hole U3cq, 6,500 ft (1,980 m) northeast of the Area RWMS. This trench was approximately 280 ft (85 m) long, 15 ft (5 m) wide, and trended approximately N60°W. The second trench, ST03, was dug within the Area 3 RWMS and across the fault trace defined by surface fractures from the BANDICOOT test, a zone 140 ft (43 m) wide and trending N10°-15°E (Emerick, 1963; Appendix A, Entry 2). Trench ST03 was approximately 440 ft (134 m) long, 25 ft (8 m) wide, and trended approximately N69°W. The west end of Trench ST03 was approximately 200 ft (60 m) south of the center of the U-3bh collapse sink and approximately 600 ft (183 m) north of USGS Trench E (Carr, 1965; Appendix A, Entry 16).

Allostratigraphic units and lithofacies were mapped along the entire north wall of both trenches (Appendix B). Soil profile descriptions were made at several locations in each trench. To facilitate subsurface mapping, level lines of known elevation and coordinates were established (surveyed) in each trench. Vertical measurements to various features were made using a stadia rod and the level lines. Locations along the mapped walls are referenced using the west end of each level line being station 0+00.

Informal allostratigraphic units (which are defined and identified by bounding discontinuities) were mapped in both trenches. Four alloformations (designated W, X, Y and Z) were mapped in Trench ST02 and three (designated L, M and N) were mapped in Trench ST03. Each formation was labeled alphabetically from oldest to youngest in both trenches and no correlations were made between the two trenches. Bounding discontinuities of alloformations were associated with soils and disconformities of the present or buried land surface. Soils marking the upper contact typically possess horizons having significant accumulation of calcium carbonate (a calcic horizon with at least Stage II morphology [Gile et al, 1966]) or a significant accumulation of clay (an argillic horizon). Within several formations there are discontinuities marked at the upper contact by more weakly expressed soils (and truncated to varying degrees) that are joined laterally by a single recognizable and traceable disconformity. These discontinuities are interpreted as marking brief, but notable, periods of landscape stability, and divide the alloformation into an upper and lower member. These allomembers are designated by a number after the formation letter (e.g., N1 and N2); the larger the number the older the unit. Detailed soil profile descriptions are presented in Appendix C, and physical and chemical laboratory data derived from soil profile samples are included in Appendix D.

Lithofacies used in mapping Trenches ST02 and ST03 (Appendix B, Appendix C) were the same as those used for pitwall and trench mapping at Area 5 (Snyder et al, 1993), except an additional unit was established for Area 3 mapping. Differentiation of lithofacies is based on sorting, grain size, clast abundance, and presence or absence of bedding. Factors controlling these features include primary influences such as stream power and pedogenesis. Within these lithofacies, there are sedimentological or pedogenic changes too small to map, but which were useful as marker beds or horizons in the detailed mapping of fractures. An additional trench (ST01) was not mapped for evidence of faulting. Soil profiles are included in Appendix C.

4.1.1 Trench ST02

ALLOFORMATION W

Allomember W1

This unit is present only at the very bottom and extreme western end of Trench ST02 (between stations 0+00 and 0+55). It has a thickness of approximately 1 ft (0.3 m). The trench floor serves as its lower boundary and Allomember W2 as its upper boundary. The contact with Allomember W2 varies from abrupt to gradual and wavy to irregular, which is the result of incision by several stream channels from the W2 unit.

The upper boundary of Allomember W1 is marked by a paleosol developed in a pebbly (25 to 50 percent), matrix-supported alluvium. This pink to pinkish-gray (7.5 YR7-8/4-2, dry) truncated soil is typically loamy sand and characterized by a rigid, carbonate-cemented Bkm horizon (Stage III and Stage IV). Cementation is continuous and strong; many clasts broke in half versus being plucked from the matrix as the trench was excavated. Horizons adjacent to the Bkm are less cemented, but thin to thick pendants of carbonate on the bottom of clasts (Stage I+ to II+) are common and opaline silica laminae are present on some clasts. Cementation in these Bk horizons occurs as discontinuous bands or layers. Ooliths (globules) are common in some of these layers. The uppermost limit of this unit (and lateral margins where it is bounded by fractures) is characterized by a discontinuous 1-in.- (2.5-cm)-thick zone of laminated carbonate and silica.

Allomember W2

This member is found near the bottom of the trench between stations 0+00 and 1+15, 1+75 and 1+90, and 2+35 and 2+60. A thickness of 0.3 to 3.5 ft (0.1 to 1.1 m) is exposed. Either the trench floor or unit W1 serve as the lower boundary, which is abrupt to gradual and wavy to irregular. Alloformation X or Y serve as the (abrupt and wavy) upper boundary.

The upper boundary of unit W2 is characterized by a paleosol developed in pebbly (35 to 55 percent), matrix- and clast-support alluvium. This truncated soil is typically sand to loamy sand and dominated by a pink (7.5YR8-7/3, dry) to pinkish-white (7.5YR8/2, dry) carbonate-cemented Bkm or Btkm horizon (Stage III- to IV-). Cementation is continuous and strong. During excavation of the trench some clasts broke in half versus being plucked from the matrix. There is a discontinuous 0.04- to 0.08-in (1- to 2-mm) carbonate lamina at the upper contact and 0.04-in (1-mm) lamina recurring along major lateral fractures throughout the alluvium. Also present are coatings of carbonate (and occasionally silica) and pendants on the undersides of clasts. At the ends of the trench there is a pink (7.5YR7-8/3, dry) Bk horizon beneath this Bkm or Btkm horizon. The Bk horizon is clast-rich (2 to 5 percent cobbles and 45 to 55 percent pebbles) and typically sand to loamy sand. It has weak to moderate carbonate cementation (Stage I+ to II+), and common, thin coatings and pendants on undersides of clasts.

The relatively unaltered alluvium (BC and C horizons) in Allomember W2 is clast-rich (1 to 2 percent cobbles and 35 to 60 percent pebbles) and typically sand. This pink (7.5YR7-8/3, dry) alluvium has Stage I+ to II- carbonate cementation. Ooliths (globules) are present, but significantly less abundant than in W1. Thin paleocarbonate coatings are common on sides of clasts. The alluvium varies from soft to hard depending upon cementation.

Allomember W2 is predominantly structureless, except where very faint relict bedding occurs in some BCk horizons. Otherwise, the unit is bedded, moderately to poorly sorted, and predominantly gravel and sand. There is evidence of channeling, with many shallow scours indicative of less-confined flow.

ALLOFORMATION X

This unit occurs in the western end of the trench (between stations 0+00 and 1+35) and the eastern part of the trench (between stations 1+80 and 2+60). A thickness of 0.3 to 5 ft (0.1 to 1.5 m) is exposed. This unit directly overlies Alloformation W or has the trench floor as its lower boundary. Alloformation Y overlies the unit throughout the trench. This upper boundary is abrupt or clear, and wavy throughout. Two members were mapped in the field. Because of limited occurrence of one unit, they are combined here for purposes of description.

The upper boundary of Alloformation X is characterized by a paleosol developed in pebbly (30 to 45 percent pebbles), matrix-supported alluvium. This truncated soil is typically loamy sand to sandy loam and dominated by a pink to pinkish-white (5-7.5YR7-8/4-2, dry), carbonate-cemented Bkm horizon (Stage III or III+). Cementation is continuous and strong with many moderately thick carbonate-cemented pendants on undersides of clasts. The upper contact is characterized by a discontinuous 0.08-in (2-mm) carbonate lamina cap and 0.04-in (1-mm) lamina recurring along major lateral fractures throughout the horizon.

Beneath the Bkm horizon, there are pink to pinkish-white (5-7.5YR7-8/2-4, dry) Bk horizons that extend throughout the length of the trench. These sand to sandy-loam horizons are clast-rich (1 to 5 percent cobbles and 25 to 50 percent pebbles). Carbonate cementation (Stage I to II-) is weak, with thin pendants on undersides of clasts.

A Btk horizon overlies the Bkm horizon in the western part of the trench. This pink (7.5YR6-7/3-4, dry), loamy-sand to sandy-loam Btk horizon has Stage III carbonate-cementation that appears to have undergone some postdepositional degradation. Consequently, despite its continuity, the cementation varies from being weak to strong. There are many thin to moderately thick carbonate- and silica-cemented pendants on undersides of clasts.

The relatively unaltered alluvium (BC and C horizons) in Alloformation X is clast-rich (1 to 5 percent cobbles and 45 to 65 percent pebbles) and matrix- to clast-supported. This pink (7.5YR7/3) to light brown (7.5YR6/3 and 10YR8-6/4, dry) sandy alluvium has Stage I- to I+ accumulation of secondary carbonate. Thin paleocarbonate coatings are common on sides of clasts. The deposit is soft to hard depending on the degree of cementation.

The alluvium in the upper part of unit X is predominantly structureless where pedogenesis has effectively obliterated bedding. Much of the unit is bedded, moderately to poorly sorted, and dominated by gravel and sand. Channels are abundant, with many shallow scours indicative of less-confined flow. At the base of the unit, the sediment is bedded and moderately to well sorted with coarse gravel and cobbles dominant. There are abundant channels with many shallow scours indicating less-confined flow.

ALLOFORMATION Y

This alloformation, which is 1 to 10 ft (0.3 to 3 m) thick, is the uppermost unit throughout most of the trench (between stations 0+65 and 2+60). The western end of the trench (between stations 0+00 and 0+65) is overlain by Alloformation Z.

Where Alloformation Y is at the surface, the upper boundary consists of a lateral series of ground soils developed in alluvium, eolian sand, or both (between stations 0+65 and 2+60). Typically, the eolian sand is 5 to 10 in. (13 to 25 cm) thick. The upper 4 in. (10 cm) of the ground soils are a brown (10YR5-7/3-4) sandy-loam A horizon. Where the eolian sand is relatively thick, and surface characteristics indicate a prolonged period of landscape stability, there is a light brown, sandy-loam (7.5YR6/4, dry) Btk horizon beneath this A horizon. Here the accumulation of secondary carbonate and silica is limited to a few thin coatings on undersides of clasts (Stage I-); thin paleocarbonate coatings are present on the sides of some clasts. There are one or more Bk horizons developed in the alluvium. These horizons are typically light brown (10YR6/3-4, dry) or pink (7.5YR7/3-4, dry) and sandy loam, with 1 to 5 percent cobbles and 5 to 50 percent pebbles. The small amount of secondary carbonate present occurs mostly as soft carbonate masses, and thin coatings and pendants on undersides of clasts (Stage I- to I).

The relatively unaltered alluvium (BC and C horizons) of Allomember Y is clast-rich (up to 2 percent cobbles, and 5 to 60 percent pebbles), matrix- or clast-supported, and typically sand to loamy sand. The color of this alluvium varies from pink (7.5YR7/3, dry) to light brown (7.5YR6/4 and 10YR7-6/3-4, dry) to reddish-yellow (7.5YR7/6, dry) depending on the accumulation of secondary carbonate (Stage I- to I). Thin to moderately thick paleocarbonate coatings are common on sides of clasts. The alluvium is soft and loose.

The upper part of Alloformation Y is predominantly structureless where pedogenesis has effectively obliterated bedding. However, most of the unit is bedded. The sediment is moderately to poorly sorted, with gravel and sand dominant. Channels are abundant, with many shallow scours indicative of less confined flow. The base of the unit has more bedding (channeling is prominent with many shallow scours indicative of less-confined flow) and the sediment is moderately to well sorted, with coarse gravel and small cobbles common.

ALLOFORMATION Z

This formation is the youngest unit in the section and occurs at the top and westernmost end of Trench ST02 (between stations 0+00 and 0+65). It is underlain by Alloformation Y. This discontinuous unit has a maximum thickness of about 8 in. (20 cm). The lower boundary is abrupt and wavy.

Two members were recognized in the field: Allomember Z1 is associated with constructional surfaces interpreted to be Middle and Late Holocene; Allomember Z2 is associated with Late Halocene (historic) constructional surfaces. Due to the thinness of these units, they are described together. The ground soils associated with these two members are developed in a clast-rich (3 percent cobbles, and 5 to 35 percent pebbles), matrix-supported alluvium. Soil development is limited to a pale brown (10YR6/3, dry) to light yellowish-brown (10YR6/4, dry), sand to loamy sand A horizon having no accumulation of secondary carbonate.

The unaltered alluvium (C horizon) of Allomember Z is clast-rich (approximately 40 percent pebbles). It is light gray (10YR7/2, dry) and sand or loamy sand. There is little secondary carbonate accumulation; thin paleocarbonate coatings are common on sides of clasts. The alluvium is soft and loose. Faint relict bedding is present, particularly in the deeper channels. The sediment is moderately to poorly sorted gravel and sand with many shallow scours indicative of less-confined flow.

4.1.2 Trench ST03

ALLOFORMATION L

This unit is present only at the bottom and ends of Trench ST03 (between stations 0+35 and 0+85, and stations 2+25 and 2+80). It has a maximum thickness of approximately 1 ft (0.3 m). The trench floor serves as its lower boundary and Alloformation M as its upper boundary. The upper contact is abrupt and wavy.

The upper boundary of Alloformation L is marked by a paleosol developed in pebbly (20 to 30 percent), matrix-supported alluvium. This truncated soil is characterized by pink (5YR7/3, dry) and brown (5YR6/4, dry) Btk and Bk horizons, having little field evidence of secondary carbonate (Stage I or I-). Accumulation is limited to a few thin coatings on undersides of clasts and carbonate filaments in the matrix. Textures vary from loam to loamy sand depending on the soil horizon.

ALLOFORMATION M

Alloformation M extends nearly from one end of the trench to the other; it is only missing from the eastern end of the trench (between stations 0+00 and 0+40). The unit is about 1 to 2 ft (0.3 to 0.6 m) thick. This unit directly overlies Alloformation L where present, or has the trench floor as its lower boundary. Allomember N1 overlies the unit throughout the trench. The upper boundary is abrupt or clear and wavy.

The upper boundary of Alloformation M is characterized by a paleosol developed in clast-rich (approximately 25 percent pebbles), matrix-supported alluvium. This light brown (7.5YR6/4, dry) to pink (7.5YR7/3, dry) truncated paleosol is sandy loam. The Btk and Bk horizons, where present, show little field evidence of secondary carbonate accumulation (Stage I-), few to common carbonate filaments, and thin coatings on undersides of clasts. There is no cementation.

The relatively unaltered alluvium (BC and C horizons) in this alloformation is clast-rich (65 percent pebbles) and clast-supported. This pink (7.5YR7/3, dry) to light brown (7.5YR6/4, dry) alluvium is typically sand to sandy loam with Stage I to II- carbonate accumulation. Only a few, thin paleocarbonate coatings occur on sides of clasts. The deposit is loose to slightly hard, depending on the degree of carbonate cementation.

The unit is predominantly structureless, moderately to poorly sorted, and with gravel and sand dominant. The lower part of the unit is similar, but bedded. Here channels are abundant, with many shallow scours indicating less-confined flow.

ALLOFORMATION N

Allomember N1

Allomember N1 extends the entire length of the trench and varies from about 1 to 3 ft (0.3 to 1 m) thick. This unit directly overlies Alloformation M, where present, or has the trench floor as its lower boundary. Allomember N2 overlies the unit throughout the trench. The upper boundary is abrupt or clear and wavy to irregular, which is the result of incision by numerous stream channels in the base of the overlying N2 unit.

The upper boundary of Allomember N1 is very distinctive. The contact is defined by a paleosol having an eolian mantle (with less than 10 percent pebbles) that overlies clast-rich (20 percent pebbles), matrix-supported alluvium. The uppermost soil horizon, a BA horizon in the eolian sediment, is brown (5-10YR6/4, dry), silt loam to very fine sandy loam, and contains common very fine roots, tubules, and vesicular pores. Beneath these horizons are Bw or Bk horizons (with minimal secondary carbonate accumulation [Stage I-]). These horizons, although lighter brown (7.5YR6/4) and somewhat coarser in texture (sandy loam), also contain ample evidence of previous root activity. Evidence of limited clay accumulation is present in some B horizons.

The relatively unaltered alluvium (BC horizon) is clast-rich (20 percent pebbles) and matrix-supported. This light reddish-brown (5YR6/3, dry) alluvium is typically loamy sand. The accumulation of secondary carbonate is limited to few filaments and the underside of clasts (Stage I-). The alluvium is slightly hard.

Allomember N1 is predominantly structureless, moderately to poorly sorted, and contains predominantly gravel and sand. The lower part of the unit is similar, but bedded. Channels are abundant, with many shallow scours indicative of less-confined flow.

Four soil samples were taken from the eolian sediment for optically stimulated luminescence (OSL) analysis (Appendix E). The samples were divided into two groups: two samples from station 2+30 and two more samples at station 2+40. Assuming a mean postdepositional volumetric water content of approximately 20 percent results in an age of 14,000 yrs for sample 4-3 and 14,500 yrs for the other three (Appendix E). This suggests that the eolian sediment accumulated on a surface that was stable during the Late Pleistocene.

Allomember N2

Allomember N2 extends the entire length of the trench, and its exposure varies from about 4 to 6 ft (1 to 2 m). This unit directly overlies Allomember N1. Its natural surface has been disturbed and covered by about 2 ft (0.6 m) of construction overburden (spoil). This lower boundary is abrupt and wavy.

The upper contact is characterized by a truncated ground soil. The uppermost soil horizon is a pink (7.5YR7/4-3) BA horizon, loam, and contains 5 to 10 percent pebbles. Very fine vesicular pores and root traces are common. Below this horizon, there are several brown (7.5-10YR6/4-3), sandy-loam Bk horizons. The accumulation of secondary carbonate is weak (Stage I-), being limited to thin carbonate coatings on undersides of clasts. The clast content ranges from 5 to 30 percent.

The relatively unaltered alluvium (BC horizons) below the Bk horizons varies from practically clast-free (1 percent) to clast-supported (65 percent pebbles), and from sand to sandy loam. The colors range from pale brown (10YR6/3) to pink (7.5YR7-6/3). The accumulation of secondary carbonate is limited to thin coatings on the undersides of clasts and occasional carbonate filaments and soft masses in the matrix (Stage I-). Thin paleocarbonate coatings are common on sides of clasts. The alluvium is soft and loose.

Very faint to distinct relict bedding is present, with weak medium to coarse, subangular blocky structure where soil development is better. Areas that have undergone little pedogenesis are bedded, moderately to poorly sorted (gravel and sand), and have abundant channeling, with many shallow scours indicative of less-confined flow. The lower portion of the unit is structureless, moderately to well sorted, and predominantly sand, silt and clay. Coarse sand is present in discontinuous lenses.

Small fragments of charcoal were found in a stream channel at station 2+45. Carbon-14 analysis of these small fragments resulted in an uncorrected age of 12,550 yrs before present (Appendix E). One soil sample was taken adjacent to the charcoal sample location for OSL analysis (Appendix E). The result of this analysis, assuming a mean postdepositional volumetric water content of approximately 20 percent is 12,500 yr. A second sample for OSL was taken above these two samples. Assuming a water content of about 20 percent results in an estimated age of 10,500 yrs (Appendix E). This suggests that net aggregation was rapid within the N2 Allomember and that the ground soil is probably Holocene.

4.2 Fractures

Allostratigraphic units and fractures were mapped in Trenches ST02 and ST03 and plotted on base maps. Fractures believed to be related to tectonic activity are shown on these maps; however, not all fractures shown are unequivocally tectonic. Fractures that are obviously related to soil structure are not shown on the maps, but are described in the text below. Fractures in both trenches are commonly hairline cracks that sometimes have concentrations of modern roots or secondary carbonate coatings, the latter being less than 0.08 in. (2 mm) thick. A few fractures are filled with thicker laminar carbonate where they cut older, carbonate-cemented strata. In gravelly deposits, fractures are often expressed as subvertical zones of weak, diffuse carbonate cementation.

The strike of a fracture was measured where expression of the plane was deemed sufficient for reasonable accuracy. Most dips appeared near-vertical. However, the dip of a fracture was usually not measured due to the difficulty of measuring true dip from a vertical exposure. The dip was estimated for a few of the gently dipping fractures. Both trenches were excavated to a depth of 10 ft (3 m), with a bench on each side at 5 ft (1.5 m) below the ground surface, resulting in an approximate 3 ft (1 m) backset of the upper face. This backset made tracing fractures between the lower and upper faces difficult.

All mapped fractures were examined for offset. In both Trenches ST02 and ST03, this process was often complicated because the orientation of paleochannels and fractures is similar to the orientation of the Area 3 fault. Strike-slip offset across any fractures can neither be demonstrated or ruled out in Trenches ST02 or ST03.

4.2.1 Trench ST02

Many fractures were noted in Trench ST02 in older, more indurated strata (Alloformations W and X), but no significant vertical offset was observed on any horizon. Most of the fractures are thought to be tectonic. The following evidence supports this conclusion:

1. The abundance of fractures in Trench ST02 relative to trenches dug in nearby unfaulted areas (e.g., Area 5; Snyder et al, 1993);
2. The distribution of these fractures in zones, and especially at the west end of the trench, as opposed to even distribution throughout the trench;
3. The splaying upward of two or three fracture sets near the west end (which is unusual, and probably cannot be related to the growth of roots or any other nontectonic explanation); and
4. A thin filling of calcium carbonate.

The carbonate could have developed since the time that underground nuclear tests were first conducted in Yucca Flat (1962), however, evidence suggests otherwise. The fillings are 0.04 in. (1 mm) thick and at least 2 ft (0.6 m) below the surface, with no fracture in the overlying younger deposits to serve as a pathway for carbonate-enriched water.

The orientation of 49 fractures was measured in Trench ST02, with the majority of fractures trending northeast. Nine fractures, clustered between stations 0+60 and 0+85, measured strikes between 15° and 30°, which is ± 5° of the 20° to 25° strike expected of the BILBY (U3cn) and CANVASBACK (U3cp) fractures at this location (Plate 2). The BILBY and CANVASBACK fracture orientations are along the general trend of the Area 3 fault.

No fractures were observed in Alloformation Z. Numerous fractures were mapped in Alloformation Y. Most of these fractures continue up from fractures in Allomember X2. In Alloformation Y, the fractures are either uncoated or weakly coated with calcium carbonate, and show preferential growth of modern roots. In general, these fractures trend northeast. No offset was found across any fracture in Alloformation Y.

Numerous nontectonic fractures related to soil ped surfaces are present in the upper soil horizons of Alloformation Y. They represent the faces of coarse prisms. Clearing of the ground surface adjacent to the trench revealed that these fractures intersect each other in a polygonal pattern typical of prismatic structure. These fractures are not shown on the map.

Fractures are more abundant west of station 0+90, and are much more abundant in Alloformations X and W than in the overlying Alloformation Y. Many fractures in Alloformations X and W are coated with calcium carbonate. Coatings are typically 0.04 in. (1 mm) thick. Fractures that cut Alloformation W generally penetrate into Alloformation X, although a few fractures are restricted solely to Alloformation W. Most of the fractures penetrating Alloformation X are truncated at the contact with Alloformation Y. Alloformations W and X are not exposed between stations 1+35 and 1+75; however, elevations of strata on either side of the unexposed area correlate well, suggesting there is no major offset of Alloformations W and X.

The abundance of fractures in the zone between stations 0+07 to 0+20 along the lower face, and changes in the nature and elevation of Allomember W2 across this zone, prompted close inspection of the area for fault-related offset. Although facies changed and erosion occurred within Allomember W2, explaining changes in nature and elevation within the unit, individual fractures revealed no offset strata. Allomember W1 is too sporadically exposed to determine whether it has been displaced by faulting. However, it does show strong fractures with laminar calcium carbonate and silica zones in several locations.

4.2.2 Trench ST03

The orientation of 71 fractures was measured in Trench ST03, and the majority trend northeast. Approximately half of these fractures are confined to Allomember N2, and generally have measured strikes between 0° to 25°, which is ±10° of the 10° to 15° strike expected of the BANDICOOT (U3bj) fractures at this location (Emerick, 1963). The orientation of the measured fractures is along the general trend of the Area 3 fault.

Three fractures are particularly significant because they cross the entire stratigraphic section exposed in the trench. Two of these fractures are between stations 1+36 and 1+39, possibly merging to become a single fracture along the upper trench face. The third fracture is near 2+46, oriented approximately 20°, and transects channel deposits. The channel strata act as marker beds where offsets of 0.2 to 0.6 in. (0.6 to 1.5 cm) were measured. The third fracture has very little carbonate filling. Modern roots are present and extend almost to the contact with Alloformation M. The fracture can be traced upward to the surface, but any offset of beds above the bench is not discernable. Above bench level, the fracture becomes narrow and indistinct.

Fractures in Alloformation M are clustered between stations 0+50 and 0+80. These fractures are too numerous to show individually at map scale. They are spaced about 6 in. (15 cm) apart, and are distinctly coated with a thin film of calcium carbonate. Orientations of these fractures are difficult to measure, due to poor exposures. Alloformation M ends abruptly at station 0+45, an area where numerous fractures are present. A close inspection of this location indicated that Alloformation M was truncated by channeling.

Between stations 0+40 and 0+50, Alloformation L is highly fractured, and has a highly irregular upper contact, due primarily to channeling. The irregularity of the top precludes interpretation of offset.

Fractures elsewhere in the limited exposures of Alloformation L are similar to, and continuous with, fractures in Alloformation M, with the exception of numerous nontectonic fractures present in the upper soil horizons of Alloformation M. These fractures represent the faces of coarse prisms. The angular relations of the fractures are in a polygonal pattern, typical of prismatic structure. In addition, local areas in Alloformation M and Allomember N2 are characterized by large blocks surrounded by carbonate-coated fracture faces. These fractures are related to soil structure and consequently are not shown on the map.

4.2.3 Conclusions

The Area 3 fault is a plane of weakness that has undergone strain resulting from stress imposed by natural events, and more recently, by underground nuclear testing. Several fractures near the center of Trench ST03 are thought to be test-induced fractures oriented with the Area 3 fault because of location, orientation, and penetration of the youngest deposits,. Calcium carbonate coatings associated with test-induced fractures are weak, and could possibly have formed since 1962, when underground nuclear testing was initiated in Yucca Flat.

In general, fractures in older deposits exposed in Trench ST03 have orientations between 40° and 60°, much less reflective of the orientation of the Area 3 fault. Conversely, the orientations of fractures in Trench ST02 that pre-date underground nuclear testing in Yucca Flat show a rough correspondence to the orientation of the Area 3 fault.

No major vertical displacement on the Area 3 fault since the Early Holocene, and possibly since the Middle Pleistocene, can be demonstrated by the continuity of alloformations in Trenches ST02 and ST03. The lack of major displacement within this time frame, and minimal vertical extent of minor fractures, suggests that waste disposal operations at the Area 3 RWMS will not be impacted substantively by the Area 3 fault within the regulatory compliance period.

5.0 SURFICIAL MAPPING

5.1 Previous Mapping

The two groups of researchers that have mapped the surficial deposits of Yucca Flat are Fernald et al, (1968) in the 1960s, and Swadley and Hoover (1990) in the late 1970s and mid-1980s. Although similar, there are significant differences between the two approaches. The map of Fernald and others (1968) first segregates surficial deposits by surficial process and landform (e.g., colluvium or fan alluvium), then by sediment character (e.g., poorly bedded rubble or well-bedded sand), and finally by provenance (e.g., volcanic or clastic rocks). The map unit delineations seem generalized, typically being large with subrounded and smooth boundaries. The line density on this 1:48,000 scale map is low. There is no information on the map regarding how the mapping was done.

Subsequent mapping by Swadley and Hoover (1990) was based on their surficial studies done throughout the NTS and southern Great Basin in the 1970s (Hoover et al, 1981). Their map identifies only alluvial, eolian, and playa deposits. The authors subdivide such sediments into age classes based primarily on topographic character (e.g., microtopography and macrotopography), drainage pattern, inset relations, soils, and desert pavement, with depositional environment and lithology as secondary criteria. The map unit delineations are more numerous, subangular, and denser than Fernald and others (1968), even though both maps were published at a scale of 1:48,000. Swadley and Hoover state that their published map was compiled from 1:24,000-scale aerial photographs and supported by very limited field observations.

5.2 Current Mapping

A geomorphic surface map was made of Yucca Flat (Plate 3) that utilizes the recent geomorphology and soil characterization work done in adjacent northern Frenchman Flat. However, rather than undertaking a substantial mapping project, the approach was to adopt the map unit boundaries (line work) of Swadley and Hoover (1990) and relabel these map units with map unit designations like those in northern Frenchman Flat (Huckins-Gang et al, 1995a,b,c; Snyder et al, 1995a,b,c,d).

5.2.1 Sample Design

The sample design is based on guidelines set forth by Forbes and others (1987), which state that transects should have at least 10 transect points, and each point should be located greater than 0.013 mi (0.20 km) apart. To evaluate map units effectively, transects should be aligned perpendicular or oblique to the predominant drainage pattern.

A 0.20 mi (0.30 km) interval was selected as the distance between transect points. A prospective transect had to be at least 1.8 mi (2.8 km) in length to encompass 10 points spaced at a 0.20-mi (0.30-km) interval. Secondary roads are abundant throughout Yucca Flat. Aerial photographs and USGS topographic maps were examined to identify all road segments (transects) of appropriate length and orientation throughout Yucca Flat. Sinuous roads were avoided because of the positional error that might result from field measurement and transcription of point locations onto the base map. A total of 30 transects were randomly located and identified on the two base field photographs.

The alluvial fans within Area 3 and the southern part of Area 7 were of greatest interest because of proximity to the Area 3 RWMS, and received a more intensive analysis. To ensure statistical reliability of the observations within this detailed study area (Barth et al, 1989), an average of approximately 20 transect points was desired for each of the three alluvial fan map units (QTa, Qap, and Qah) delineated on the Swadley and Hoover (1990) base map. From the 10 prospective transects located within the area, six primary transects and four alternates were randomly selected (yielding 60 transect points). If any of the six primary transects were undriveable or otherwise unsuitable, an alternate transect was used.

Additional transects were selected subjectively to be physiographically representative of the different terrains and geomorphic surfaces outside Area 3 and southern Area 7. Of the 20 prospective transects outside the detailed study area, 6 were identified as likely to yield an additional 60 transect points throughout Yucca Flat. An additional nine plots not associated with any of the transects in Yucca Flat were done in conjunction with existing soil profile excavations to compare surface information with more detailed soil data.

5.2.2 Mapping Uncertainty

Two distinct types of mapping uncertainty are inherent in a study of this type. Cartographic error is uncertainty inherent in the cartographic plotting of map unit delineations onto a base map. Positional error is the uncertainty associated with correctly identifying a point on the landscape and transcribing it to the base map (National Institute of Standards and Technology [NIST], 1992).

Cartographic error can be defined as the ground distance represented by the width of the line used to inscribe the delineations on the base map (Forbes et al, 1987). Cartographic error is entirely scale-dependent and inversely proportional to the map scale, meaning error increases as map scale decreases. A point or line on a map cannot be described with more accuracy than its own physical representation will allow, so cartographic error is fixed and unavoidable in any mapping exercise. For this study, cartographic error was defined by the 0.01-in (0.25-mm) line width of the map unit delineations on Swadley and Hoover's (1990) base map. This line width corresponds to 40 ft (12 m) of ground distance. Hence, 40 ft (12 m) was accepted as the minimum error (at a 1:48,000 scale) and was used as the minimum offset distance from all roads for the transects, and the radius of the evaluation plot surrounding the transect point.

Positional error is scale-dependent, but also varies with proximity to topographic control points, field measurement techniques, and distortion of the photographic base. To evaluate positional error, it was necessary to define the threshold at which observations at a sample point might differ in character from the named map unit, but still not reflect on the accuracy of the delineation. The frequency of observations that fall on or adjacent to a map unit boundary increases as line density on the map increases. Inclusions are areas on the landscape too small to be delineated or are otherwise unsuitable for cartographic presentation at the published scale. The minimum length of a map unit delineation on the base map of Swadley and Hoover (1990) was determined to be approximately 0.08 in. (2 mm), which corresponds to approximately 300 ft (90 m) of ground distance. A value of 0.08 in. (2 mm) was assumed to be a conservative, but reasonable, estimate of the maximum expected positional error.

5.2.3 Transect Procedure

The map and photographic coverage used for transect work was:

- 1:48,000 surficial deposits map of Yucca Flat (Swadley and Hoover, 1990);
- Photocopies of original 1:24,000 surficial deposits mapping sheets used to compile the 1:48,000 map of Swadley and Hoover (1990);
- 1:9,950 color, 1:20,000 color, and 1:24,000 black-and-white aerial photographs;
- 1:24,000 USGS topographic maps.

In addition, map unit descriptions of surficial deposits in Yucca Flat (Swadley and Hoover, 1990) and geomorphic surfaces (Huckins-Gang et al, 1995a,b,c; Snyder et al, 1995a,b,c,d) in northern Frenchman Flat (Tables 5-1 and 5-2) were studied and taken to the field.

The steps used to locate each transect point and corresponding evaluation plot were:

1. Select a starting location on a road segment (transect) at, or a measured distance from, a ground control point. The control point was a (point) feature clearly identifiable in the field, on an aerial photograph, and on a topographic map.
2. At the starting location, select an upslope or downslope direction perpendicular to the road. Typically, the upslope direction was selected to avoid possible effects of runoff from the road. Pace a distance of 40 ft (12 m) from the edge of the road to establish the transect point (the evaluation plot center). If the plot was found unsuitable (e.g., human surface disturbance or radioactive contamination), additional 40-ft (12-m) intervals were paced off. If an acceptable area could not be located after four 40-ft (12-m) intervals, then the attempt to establish that transect point was abandoned. All established transect points were marked on the aerial photograph.
3. A transect point description form (Figure 5-1) was completed for the most extensive component landform within the 40-ft (12-m) radius plot. To obtain data for the soil mantle, a small hole was excavated to a depth of 10 to 12 in. (25 to 30 cm).
4. A vehicle odometer was used to measure 0.20 mi (0.31 km) to the next transect point, except for Transect 30 where an interval of 0.40 mi (0.62 km) was used.

Landscape and soil characteristics were recorded on a transect point description form (Figure 3). Surface pavement was separated into four classes based on the percentage of surface area covered by pavement. Surface pan fragments (i.e., carbonate- or silica-rich platelets exhumed

Table 5-1. Summary of map unit differetiae of Swadley and Hoover (1990).

Map Unit Characteristic	Map Unit Designation		
	QTa	Qap	Qah
Estimated Age	Early Pleistocene or Pliocene	Late to Middle Pleistocene	Holocene
Component Landforms	Moderately dissected fan deposits flanking bedrock hills	Fan deposits flanking bedrock hills; inset fan or stream terrace deposits	Stream channel or terrace; fan deposit near present drainage
Consolidation	Moderately to well consolidated	Weakly to moderately well consolidated	None to weakly consolidated
Clast Diameter	Commonly 1.0 m or larger	Mostly less than 0.5 m, occasionally up to 1.0 m	Mostly less than 0.5 m, rarely up to 1.0 m
Desert Pavement	Dense packing, includes pan fragments	Moderate to dense packing with well-developed varnish	None
Color	Not stated	Light gray to light grayish brown	Light to light brownish gray
A Horizon	Vesicular eolian cap	Vesicular eolian cap	Minor alteration
B Horizon	Extensive leaching/oxidation	Significant leaching/oxidation	Little to minor leaching/oxidation
Carbonate Stage	Stage III or IV, up to 2 m thick	Stage II to Stage III or IV in upper part, up to 1 m thick	Stage I, less than 1 m thick
Diagnostic Horizons	Argillic, petrocalcic	Cambic, argillic, calcic, or petrocalcic	None or cambic

Table 5-2. Summary of map unit differentiae of Huckins-Gang et al, 1995a,b,c; and Snyder et al, 1995a,b,c,d.

Map Unit Characteristic	Map Unit Designation						
	S2	S3	S4	S5a	S5b	S6	S7
Estimated Age	Middle Pleistocene	Late Pleistocene	Late Pleistocene	Early Holocene	Middle Holocene	Late Holocene	Late Holocene
Component Landforms	Broad fans; Small fan remnants; Ballenas; Colluvial slopes; Pediments	Broad fans; Terraces; Abandoned drainages; Colluvial slopes; Pediments; Sideslopes of older surfaces	Broad fans; Terraces; Abandoned drainages; Colluvial slopes; Sideslopes of older surfaces	Broad fans; Terraces; Abandoned drainages; Colluvial slopes; Sideslopes of older surfaces	Broad fans; Terraces; Abandoned drainages; Colluvial slopes; Sideslopes of older surfaces	Terraces and bars along active drainages; Broad fans; Small colluvial fans	Bottoms and sideslopes of active drainages
Surface Topography	Smooth; muted bar-and-swale; clasts buried by eolian mantle	Smooth; muted bar-and-swale; clasts nearly buried by eolian mantle	Muted bar-and-swale; clasts partially buried by eolian mantle	Subdued bar-and-swale	Subdued bar-and-swale	Unaltered bar-and-swale	Unaltered bar-and-swale
Vegetation Density	Sparse shrubs and annuals	Common shrubs and annuals	Common shrubs and annuals	Common shrubs and annuals	Common shrubs and annuals	Few shrubs and annuals	Sparse annuals
Animal Burrows	Uncommon	Uncommon	Common	Common	Common	Common	Absent
Desert Pavement	Well expressed over extensive areas; common carbonate platelets	Well expressed over large areas	Well expressed over large areas	Moderately expressed over large areas	Incipient over small areas	None	None
Clast Varnish & Rubification	Well expressed; dark	Well expressed	Moderately to well expressed	Incipient	None to incipient	None or inherited	None or inherited
A Horizon	Thick vesicular eolian mantle	Thick vesicular eolian mantle	Vesicular eolian mantle	Irregular, thin eolian mantle	Some eolian influences	Thin, non-eolian	None to thin, non-eolian
B Horizon	Btkm	Btk	Bk or Btk	Bw or Bk	Bw or Bk	None	None
Carbonate Stage	Stage III to Stage IV	Stage II to Stage III	Stage I+ to Stage II	Stage I to Stage I+	Stage I	Stage I-	None
Diagnostic Horizons	Argillic, petrocalcic	Argillic, calcic	Argillic, calcic	Cambic	Cambic	None	None

Description of Transect _____ Point _____ Date: _______________

Distance from road to the transect point (center of evaluation plot): ________ feet

List deviations in protocol to establish evaluation plot: ____________________________

On the component landform within the plot, evaluate the following:

Identify key *uninherited* surficial characteristics used to assign surface designation:

Perennial Vegetation:	<5%	5-25%	25-50%	>50%	
Microbiotic Crust:	None	<5%	5-25%	25-50%	>50%
Firmness of Surface:	Loose	Soft	Somewhat Firm		Very Firm
Surface Pavement:	None	<25%	25-75%	>75%	
Bar-and-Swale Topography:	Unaltered	Subdued	Muted	Smoothed	
Pan Fragments:	None	<5%	5-25%	25-50%	>50%
Varnish:	None	<50% (light)		>50% (dark)	
Rubified Clasts:	None	<25%	25-50%	>50%	

Eolian Cap: _________ cm thick

Soil Color: ________ A horizon _________ B horizon

Soil Structure: _________ A horizon _________ B horizon

Argillic Horizon:	Absent	Present in Cap	Present in Alluvium	
Secondary Carbonate:	Stage I	Stage II	Stage III	Stage IV

Slope Gradient (long-axis): _________ %

Type of Surface: Constructional Erosional Undetermined

Other:____

Does component landform fit the map unit description on base map? Yes No

If not, is minimum length of component landform less than 300 feet? Yes No

What surface would we assign to component landform? 2 3 4 5a 5b 6 7

List % composition of surfaces within the evaluation plot: ________________________________

Figure 5-1. Transect point description form.

from an underlying hardpan) were grouped into five classes based on the percentage of surface fragments they comprised, and rubification was characterized using four classes based on the percentage of rubified surface clasts present. Desert varnish was separated into three categories based on visual estimates of development. Microbiotic crusts (cryptogams) and perennial vegetation were separated into classes based on the percentage of surface area covered. Surface firmness and bar-and-swale topography were rated qualitatively.

The slope gradient was measured with an Abney level. Thickness of an eolian cap (mantle) was measured if present. Color and structural characteristics of the A or B horizons were recorded (Soil Survey Division Staff, 1993) and development of argillic or shallow carbonate-rich horizons was described. Any other characteristics thought to be relevant, such as clast lithology of the alluvium were also recorded. It was determined whether the transect point was located on a landform with a long axis less than 300 ft (90 m). A geomorphic surface map unit designation from northern Frenchman Flat was assigned to the dominant surface of the landform. Finally, the proportion of different surfaces within the evaluation plot was estimated.

5.2.4 Data Compilation

Twelve transects, yielding 119 transect points (evaluation plots), were selected from 30 prospective transects. An additional nine evaluation plots were recorded. The location of each transect point was transcribed from the field photographic base to the 1:48,000 map of Swadley and Hoover (1990) with the aid of 1:24,000 USGS topographic maps. Next, each transect point was assigned to the name of the map unit that it fell within. The transect points were tabulated, resulting in a preliminary correlation chart similar to Table 5-3. Despite some dispersion of the data, this preliminary correlation chart contained three groups: QTa deposits associated with S2 and S3 surfaces; Qap deposits associated with S3, S4, and S5a surfaces; and Qah deposits associated with S5a, S5b, S6, and S7 surfaces. Transect points outside of these groups were then analyzed to determine if they were map unit inclusions. There was a more appropriate Swadley and Hoover (1990) designation based on considerations of position error; or they differed grossly from the Swadley and Hoover (1990) unit designation. Criteria for this analysis were:

1. Landform described in the field was shorter than 300 ft (90 m). The transect point retained the original Swadley and Hoover (1990) map unit designation and was called an *inclusion.*
2. Landform described in the field was longer than 300 ft (90 m), the transect point was 0.08 in. (2 mm) or less from a map unit boundary (the estimate for positional error), and the field description matched an adjoining Swadley and Hoover (1990) map unit. The transect point was reassigned the matching map unit designation and was called a *boundary correlation.*
3. Landform described in the field was longer than 300 ft (90 m), the transect point was 0.08 in. (2 mm) or less from a map unit boundary (the estimate for positional error), and the field description did not match an adjoining Swadley and Hoover (1990) map unit. The transect point retained the original map unit designation and was called an *outlier*.
4. Landform described in the field was longer than 300 ft (90 m), the transect point was greater than 0.08 in. (2 mm) from a map unit boundary (the estimate for positional error), and the field description did not match the surrounding Swadley and Hoover (1990) map unit. The transect point retained the original map unit designation and was called an *outlier.*

Table 5-3. Final Correlation of Frenchman Flat geomorphic surface units with surficial deposit units of Swadley and Hoover (1990).

Geomorphic Surfaces	Swadley and Hoover (1990) Map Unit			
Map Unit	**QTa**	**Qap**	**Qah**	**Tr**
S2	17 105 106	<108>	[10]	
S3	6 7 9 24 28 29 30 51	1 13 15 19 20 25 *31* 47 94		
	52 54 55 93 95 120			
S4	<97> <99>	2 8 *14* 22 26 32 33 38 *39* 56 57 62	<36> <71> <72>	<5>
		63 64 *65* *66* *76* 78 80 *82* *83* 90 96	<74> [79]	
		101 111 *114* *115* *116* 117 119 121 123		
S5a	[11] [23]	12 *16* 37 40 *41* 42 43 *44* 45 49 58	*3* 21 46 53 60 *70* 73	
		59 61 67 *68* 81 86 89 98 *100* 109	75 *77* *85* 87 107 124	
		110 112 122 128		
S5b		[4] [34] [48]	*18* 27 *35* *50* *69*	
			102 113 127	
S6	[92]	[84]	91 126	
S7			88 125	

LEGEND: Boundary correlations are in italic.
Inclusions are in [ ] brackets.
Outliers are in < > brackets.

NOTE: Evaluation plots 120 through 128 were not part of any transect.

This analysis resulted in a final correlation chart (Table 5-3). The chart shows a consistent relationship between the geomorphic surfaces as mapped in northern Frenchman Flat and the surficial deposits delineated by Swadley and Hoover (1990): S2 and S3 surfaces fit the QTa delineations; S3, S4, and S5a surfaces fit the Qap delineations; and S5a, S5b, S6, and S7 surfaces fit the Qah delineations. These relationships were then used to relabel the map unit boundaries (line work) of Swadley and Hoover (1990). The result was Plate 3.

Table 5-3 also shows that two geomorphic surfaces are split between surficial deposit units: S3 between QTa and Qap, and S5a between Qap and Qah. A review of the transect point description sheets found no field characteristics that would result in consistently partitioning either S3 into QTa and Qap, or S5a into Qap and Qah. However, it is possible that Swadley and Hoover (1990) had some difficulty in consistently segregating surfaces of similar classes (age) that have different tone or texture on a photograph. On the map, Swadley and Hoover (1990) state that "[t]his map was prepared from aerial photographs and from very limited field observations." Any such errors of photographic interpretation had a small probability of being corrected because of limited ground truthing.

Table 5-4 shows that 85 percent of the transect points were either direct or boundary correlations (the latter considers precision error). Eight percent of the transect points were classified as inclusions, meaning these points represented areas smaller than the minimum delineation size of the 1:48,000 map. The inclusions were evenly distributed among the transects. Correlations and inclusions represented 93 percent of the observations, leaving just 7 percent of the transect points as outliers. Of these outliers, two were closely spaced in one transect, and three were closely spaced or consecutive in a second transect (Table 5-3). Seven of the eight outliers involved the classification of S4 surfaces (Table 5-3). The data indicate that the map of Swadley and Hoover (1990) does not, on occasion, segregate Qap map units (where all other S4 observations occur) from QTa or Qah map units; and the S4 surfaces are not uncommon inclusions in S2, S3 map units, and S5, S6, S7 map units. This fact does not reduce the accuracy of adopting the line work of the Swadley and Hoover (1990) map.

Table 5-4. Transect point and evaluation plot tally.

Transect	Correlations	Boundary Correlations	Inclusions	Outliers
2	6	1	2	1
3	7	2	1	—
4	8	—	1	1
5	6	3	1	—
8	6	3	1	—
10	10	—	—	—
12	4	6	—	—
16	4	2	1	3
21	6	3	1	—
23	6	1	1	2
29	8	1	—	1
30	6	3	—	—
Total	77	25	9	8
Proportion	64%	21%	8%	7%

6.0 PEDOLOGY

Description and analysis of soils in trenches and across the landscape of Yucca Flat were integral to understanding the surficial geology in the vicinity of the Area 3 RWMS. Of three soil trenches dug (ST01, ST02 and ST03), two ST02 and ST03 (Plate 2, Appendix B), were excavated along the trace of the Area 3 Fault to search for subsurface evidence of faulting (Section 4.0). Numerous small excavations were described (Soil Profiles EX01-P01 through EX09-P01, Appendix C) to help develop a geomorphic surface map of Yucca Flat (Section 5.0, Plate 3)

6.1 Profile Descriptions and Sample Analysis

Soil profile descriptions and characterization data were integral in establishing the allostratigraphy in the two soil trenches (Section 4.0). Typically, identification of the bounding discontinuity between allostratigraphic units was based on recognition and correlation of ground soils or buried (truncated) paleosols. Field and laboratory analyses were useful for segregating different allostratigraphic units and different geomorphic surfaces. The principal discriminators were soil structure and consistence, secondary carbonate accumulation, and clay accumulation. Twenty-four soil profiles were described according to protocols of the National Cooperative Soil Survey (Soil Survey Division Staff [1993,1994]). The detailed descriptions are in Appendix C. Eighty-five samples from 12 soil profiles were collected for physical and chemical analyses (Appendix D).

6.1.1 Soil Structure and Consistence

A key criterion used to identify the solum (A and B horizon) of a soil is obliteration of all or much of the original geologic structure, in this case, fine stratification in alluvium (Soil Survey Division Staff, 1993). However, most of the alluvium observed in exposures constituting the C horizon of a soil had bedding that was readily discernible, with very coarse to medium sand grains [(0.08 to 0.02 in. (2 to 0.05 mm) in diameter] recognizable to the unaided eye. In pedologic terms, this is a single grained (structureless) condition.. The sediment typically was loose with limited cementation by calcium carbonate and silica.

Overlying many C horizons are BC horizons where the bedding has been partially obliterated, but evidence of structure is absent. This structure is termed massive (structureless). Field evidence indicates that such massive horizons are the consequence of physical reorganization primarily by roots, insects, and some chemical transformations initiated by percolating water. In conjunction with the physical reorganization, respiration by plant roots may alter the chemical environment, producing a zone of chemical weathering around the root.

In the older allostratigraphic units in Yucca Flat, there are soils with B horizons that have better, albeit weak, structural development than the BC horizons. Here, pedogenesis (soil formation) has progressed to the point where the original bedding has been obliterated and the soil particles have reorganized into three-dimensional units (peds) separated by surfaces of weakness. Typically, the structure is medium to coarse subangular blocky.

6.1.2 Secondary Carbonate and Silica

Another key criterion used to identify the solum (A and B horizons) of a soil is the transformation, accumulation, or loss of secondary carbonate and silica (Soil Survey Division Staff, 1993). Soils developed under arid and semiarid climates often have accumulations of secondary calcium carbonate, silica, or both. The profiles described in Appendix C have such accumulations. The general pattern of carbonate accumulation follows that first outlined by Gile et al, (1966) for arid soils in southern New Mexico; the notation (stage) used in this study to describe this pattern follows Birkeland (1984).

In general, the sediments that retain sedimentary bedding (C horizons) have very little, if any, secondary carbonate present (no carbonate stage). The small quantity of carbonate present occurs as very thin, discontinuous coatings on the bottom of clasts (Stage I). In a few C horizons, some pebbles are weakly cemented to the bottom of larger clasts (Stage I+ and designated Ck horizons). In BC horizons, carbonate usually coats the bottoms of quartzite and carbonate clasts and the entirety of pyroclastic volcanics (Stage I). Areas where cemented pebbles and sand form pendants on bottoms of clasts (Stage I+ and designated BCk horizons) are common. In B horizons, carbonate usually coats the entirety of all clasts regardless of lithology (Stage I) and, again, there are areas where cemented pebbles and sand form pendants on bottoms of clasts (Stage I+ and designated Bk horizons). Transitional BA horizons may or may not show evidence of carbonate accumulation.

Related to the accumulation of secondary carbonate is the removal or etching of paleocarbonate coatings from clasts. This paleocarbonate is carbonate that accumulated on the clasts prior to their deposition at their present locale. It may have originated as pedogenic carbonate in another soil upslope that was subsequently eroded or as carbonate from gully-bed cementation. Either way, the exotic character of the paleocarbonate is recognizable due to the random juxtaposition of the coatings on clasts: some clasts are entirely coated, whereas adjacent clasts are uncoated, and still others have coatings only on the sides or tops. Removal or etching of the paleocarbonate provides further clues to the presence of pedogenic horizons. The general pattern of paleocarbonate occurrence is:

- In C horizons (unaltered sediments), coatings are random on adjacent clasts;
- In Ck horizons, coatings have been only partially removed from the tops and sides of clasts;
- In BC horizons, coatings have been removed from the tops and often the sides of all but the largest clasts; and
- In B horizons, coatings remain only as laminated paleocarbonate encompassed by pendants of more recent carbonate.

6.1.3 Clay Accumulation

Another key criterion used to identify the solum (A and B horizon) of a soil is the translocation and accumulation of clay and clay-sized minerals in B horizons (Soil Survey Division Staff, 1993). In general, horizons that retain sedimentary bedding (C and some BC horizons) have very little, if any, clay accumulation. In B horizons, clay may coat the surfaces or corners of peds or the contacts between peds and fine pebbles. Transitional BA horizons may or may not show evidence of clay accumulation.

6.2 Relationship of Soils and Geomorphic Surfaces

Development of the geomorphic surface map for Yucca Flat (Section 5, Plate 3) documented and utilized the soil-surface relationships that occur across the landscape. Soils associated with Late Holocene surfaces (S6 and S7 constructional surfaces) are limited to a weak A horizon, whereas soils associated with Early and Middle Holocene surfaces (S5 constructional surfaces) have structural or color B horizons, with some evidence of carbonate accumulation (Stage I or Stage I+). An eolian mantle effects the development of older soils. Soils of Late Pleistocene surfaces (S4 constructional surfaces) have thicker B horizons than those of the oldest Holocene soils. The B horizons contain more secondary carbonate (Stage I+ to Stage II) and can show evidence of clay accumulation (weakly developed Btk horizons). The Middle Pleistocene surfaces (S3 constructional surfaces) typically have soils with Bt horizons developed in the eolian mantle, if the mantle has not been truncated by erosion. These soils also have B horizons with Stage II to Stage III carbonate accumulation, as well as some silica. The most well-developed soils with regard to accumulation of clay and secondary carbonate are associated with the Early Pleistocene surfaces (S2 surfaces). These soils are almost universally truncated, leaving thick, indurated, carbonate-rich B horizons (Stage III to Stage IV) near the land surface.

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APPENDIX A

ANNOTATED BIBLIOGRAPHY

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The following annotated bibliography is in chronological order. Observations specifically relevant to the Area 3 fault or other fault-related features are summarized for each entry. Editorial notes and interpretations are presented in italics. Fractures and test sites discussed in this appendix are shown on Plate 2. Pretesting lineaments and geophysically inferred faults from previous studies are shown on Plate 4.

1. **Namco International, Inc., December 1962, Seismic survey report, Nevada Test Site Area No. 3, Nye County, Nevada: Dallas, Namco International, Inc., submitted to U.S. Coast and Geodetic Survey, unpaginated.**

Seismic reflection and refraction surveys were undertaken south of the Area 3 RWMS to determine whether faults are present near designated test sites, and whether seismic methods would depict the position of the Yucca fault in the immediate area. The study consisted of three seismic lines, with Line 1 trending N65EW and 1,500 ft (460 m) south of U3bj. Seismic refraction yielded unusable data and was abandoned in favor of seismic reflection.

Two reflecting horizons were noted on the seismic profiles. An "outstanding" reflection was termed "A" and thought to represent the base of alluvium. The depth of the alluvium at SP [shot point] 8 is 1,550 ft (470 m). The second reflection, termed "B", ". . . is approximately 200 ft [60 m] deeper and is probably associated with a member within Oak Springs." *Oak Springs was the formation name used at that time for the entire section of Tertiary volcanic rocks*. The "Magnitude of faulting on Reflection 'B' is approximately the same as that on Reflection 'A'." No usable deeper reflections were obtained because "Such reflections are obscured by interference of reflections migrating from steep flanks to the east and west." The authors state ". . . data on Line 3 near the Yucca fault are too poor for fault interpretation."

Three normal faults at the base of alluvium were interpreted on the basis of Lines 1 and 2. The most westerly fault, "A", was interpreted from "fair to good" evidence on Lines 1 and 2 to have a throw of approximately 150 ft (45 m) up to the west. Based on the sheets, fault "A" on Reflection "A" passes about 2,000 ft (610 m) west of the Area 3 fault as later mapped through U3bj. "The fault evidence [of fault "B"] on Line 1 is fair and on Line 2 is poor." The maximum throw was interpreted to be 65 ft (20 m) up to the west. On Reflection "A", fault "B" passes 1,000 ft (305 m) to the east of U3bj. The most easterly fault was designated fault "C," but evidence was ". . . poor on both Lines 1 and 2 . . ." In summary, the authors state: "The seismic reflection data obtained in the area surveyed definitely indicate two normal faults with strike approximately N22EE, and a throw at the base of the alluvium of 65 to 150 feet [20 to 45 m]. A third similar fault is probably existent."

The only drill hole data available for the area of this study is the log of Ue3c (Dixon et al, 1973); the log shows that Reflection "A" is probably the top of the Rainier Mesa Member of the Timber Mountain Tuff (Tmr) in this area.

2. **Emerick, W. L., January 1963, Effects of experimental shot in drill hole U3bj, Area 3, Nevada Test Site, Nye County, Nevada: U.S. Geological Survey Technical Letter Yucca-38, 6 p.**

The test at U3bj (BANDICOOT; September 19, 1962; 12.5 kiloton (kt) [DOE, 1994]) formed a nearly vertical crack trending 10E to 15E northeast in the U3bj collapse sink and, on the same trend, a 140-foot- (40-m)-wide zone of cracks extending from the collapse sink about 1,000 ft (305 m) to a point 100 ft (30 m) from the southeast rim of the U3bh collapse sink. *This was the first expression noted of the Area 3 fault, although it was not named as such at this time.* The field check for cracks extended 5,000 ft (1,520 m) from approximately 1,500 ft (460 m) south of U3bj to approximately 1,500 ft (460 m) north of U3bk. The cracks, most less than 0.125 in. (3 mm) wide, were found both north and south of U3bj. Only two cracks were south of U3bj, a distance of 800 to 1,000 ft (240 to 305 m) from the crater, and cracks north of U3bj extended from that crater to within 100 ft (30 m) of U3bh crater *[approximately 1,000 ft (305 m) northeast from U3bj].*

Emerick also mentions a "northeast trending fracture or zone of weakness hundreds of feet long" extending from U3ak. *These fractures do not appear on subsequent compilation surface effects maps.*

3. **Colton, R. B., February 1963, Fault traces in alluvium and in Rhyolite Hills in Areas 3, 7, 9, 10, and 15, Yucca Flat, Nevada Test Site: U.S. Geological Survey Technical Letter Yucca-41, 5 p.**

The objective of the study was ". . . to determine if natural fault traces or other surface indications of natural fractures in the alluvium could be detected; particular attention was given to the area around drill hole site U3bj where a north-northeast-trending fissure was produced by the explosion." *[subsequently defined as part of the Area 3 fault].* The author examined 1:12,000-scale aerial photos taken June 6, 1962 *[prior to the U3bj (BANDICOOT) event on October 19, 1962]*, and earlier 1:40,000-scale and 1:60,000-scale aerial photos. "No lineation could be seen on these pre-U3bj photographs [1:12,000-scale photos] to suggest that a fault, joint, or fissure existed in this area prior to the event." Other areas of north Yucca Flat also were examined. "All such lineations that could be detected on the photos apparently are offshoots of the Yucca fault. The Yucca fault… is actually a fault zone, in places as much as 3,000 ft [915 m] in width."

4. **National Geophysical Company, Inc. (formerly Namco International, Inc.), February and March 1963, Seismic survey report, Nevada Test Site, Area No. 3–supplement, Nye County, Nevada: Dallas, National Geophysical Company, Inc., submitted to U.S. Coast and Geodetic Survey, unpaginated.**

The study added four new seismic reflection lines to the previous seismic study by Namco (Namco International Inc. (December 1962). The objectives of the supplemental seismic lines were to expand the reflection program of December 1962, which was to determine the presence or absence of faulting in Area 3; and to determine whether shallow reflections in the alluvium could be obtained to correlate with difficult drilling conditions in the alluvium.

The new lines were in Area 3 north of the previous study. Three lines trended S60°E and north-south. Deviations occur in the assigned lines because of collapse sinks, structures, and test sites. The two reflections (A and B) found in the initial survey were discernable in these new seismic lines.

Enclosure #3 (Structure contour map of Horizon "A") from this report shows three faults east of the Yucca fault. Fault "A" is an extension of "A" from the first study. The fault is bent into a north-south orientation and brought north into the area of the U3ax collapse sink to an area of poor continuity on Line 6, and ends before reaching Line 5. The southern part of fault"B" is unchanged from the previous Namco report. The northern part of fault "B" was changed to an orientation of N7EE by a bend just north of Line 1 and shown to pass through U3bj (BANDICOOT). *This could indicate that the U3bj fracture zone influenced the interpretation of the seismic data, but the fault is not drawn with the same orientation as the BANDICOOT fractures, which were N10-15EE (Entry 2).* Fault "B," as mapped in this report, extends with an average trend of N12EE as far north as 842,100N, 690,350E, roughly the position and orientation of the as yet unknown Area 3 fault. Fault "C," the easternmost besides the Yucca fault, is shown as a dashed line. *The easternmost fault from the previous Namco study (Entry 1), fault "C," is not the same as fault "C" in this report; it was deleted because it was not seen on Lines 5 and 6.*

"The fault relations near 838,000N-690,000E are open to question. However, Oak Springs elevations derived from U3bf and U3bt definitely confirm fault 'C' on Line 4. This relation requires faulting to occur near the coordinates given above, but the data are locally poor."

Why the authors reached this conclusion is unclear. The elevation of the base of the alluvium in U3bf, on the side of the fault mapped as downthrown, is 3,000 ft (915 m), and in U3bt, on the side mapped as upthrown, it is 2,870 ft (875 m). The elevations at the top of the Rainier Mesa Member in drill holes U3bf and U3bt are 2,860 and 2,730 ft (870 and 830 m), respectively (Drellack and Thompson, 1990). The coordinates mentioned (838,000N-690,000E) are not near fault "C" but are on fault "B" near the N42EE branch just south of U3cn (BILBY).

5. Healey, D. L., March 1963, Correlation of gravity data and faulting in Yucca Flat, Nevada Test Site: U.S. Geological Survey Technical Letter Yucca-43, 11 p.

Faults inferred from gravity data are shown on a map in this report, The Area 3 fault is not shown.

6. Hazlewood, R. M., Healey, D. L., and Miller, C. H., April 1963, U.S. Geological Survey investigations of Yucca Flat, Nevada Test Site, Part B–geophysical investigations: U.S. Geological Survey Technical Letter NTS-45, 53 p.

This report contains a Bouguer gravity map of the Yucca Flat area, and a structure contour map of the upper surface of the pre-Cenozoic [Paleozoic] rocks. Two closed gravity anomalies occur north of the Area 3 fault. The western anomaly is a gravity high and the eastern anomaly is a gravity low.

The two anomalies might be interpreted as straddling the northward projection of the fault, with the east side down. However, based on the structure contour map, the high- and low-gravity anomalies might correspond, respectively, to a topographic high and a low in the surface of the pre-Cenozoic rocks. Varying lithologies are an alternative explanation for the gravity differences. Few boreholes in Yucca Flat penetrate into the pre-Cenozoic rocks so control is limited.

7. Williams, W. P., Emerick, W. L., and Davis, R. E., November 1963, Geologic appraisal of the U-3cs Site and vicinity, Area 3, Yucca Flat, Nevada Test Site: U.S. Geological Survey Technical Letter Yucca-53, 13 p.

The purpose of the study was ". . . to briefly recount the evidence in support of the existence of this zone of weakness [Area 3 fault] and to review the geologic setting of the U-3cs site . . .". "The U-3cs site lies about 2,700 ft [820 m] southeast of the Bilby [U3cn] ground zero and is roughly on a zone of fractures defined in the alluvium that trends about N18EE through sites U-3bj (BANDICOOT) and U-3cq (abandoned) (approximately 2,700 ft [820 m] east of BILBY ground zero)," ". . . and is herein referred to as the Area 3 fault." The width of the zone of weakness related to the Area 3 fault near U-3cs and U-3cq is 600 to 700 ft (183 to 213 m).

The report, published shortly after the September 1963 BILBY test (Entry 8), includes a drawing of the BILBY surface effects. Mentioned in the text is the pre-BILBY collapse of the large-diameter drill hole U-3cq within the "BILBY fracture zone." *This collapse is taken as evidence that U-3cq is on the Area 3 fault. The Area 3 fault has consistently been drawn through U-3cq on subsequent plan maps.*

"A gap in the continuity of the surface cracks, about 2,500 ft (760 m) long . . ." ". . . exists in the area centrally located between U-3cs and U-3bj." This gap is not considered significant because of the alignment of the two zones (of cracks) and their persistence both north and south (of the gap). The U-3cs site, which is shown to be on the Area 3 fault in the 1:24,000-scale sketch map and about 70 ft (20 m) southeast of the zone on the larger scale location map, was later abandoned as a test location.

8. **Williams, W. P., February 1964, Surface effects of the Bilby event, U3cn Site, September 1963, Area 3, Yucca Flat, Nevada Test Site: U.S. Geological Survey Technical Letter NTS-68, 17 p.**

After the event at U3cn (BILBY; September 13, 1963; 249 kt [DOE, 1994]), Williams mapped a northeast-trending zone of fractures "traceable, though not continuously, for a total distance of 9,000 ft [2,740 m]." *Williams tentatively called this feature the Area 3 fault [he first used this term in November 1963 in his (and others) report on U-3cs] and postulated that it may connect with the BANDICOOT fractures, thereby increasing its length to 14,000 ft (4,270 m).* Williams noted that the southwestern extent of the Area 3 fault was somewhat indeterminate ". . . because with increasing distance from ground zero it becomes increasingly difficult to differentiate between what might be a waning Bilby effect and an effect from another smaller, but closer event." A 3,000-ft (915-m) interval between the southwestern end of the mapped fracture zone and the BANDICOOT fractures is represented on the map accompanying the report by lines interspersed with question marks. *This pattern may represent either a zone of fractures that was not obviously an effect of BILBY or the hypothetical connection of the two zones (Entry 7). However, the lines and question marks probably do not represent mapped fractures because of the pattern's straightness and regular spacing.* A down-to-the-west displacement of 6 in. (15 cm) was noted on the Area 3 fault about 3,000 ft (915 m) southwest of the BILBY ground zero, near the U-3da site. However, this displacement is not on the line later drawn as the main trace of the fault. Minor (less than 0.5-in [1.25-cm]), east-facing scarps were formed northwest and southwest of this scarp. A 5-in (13-cm), west-facing scarp also formed in a road about 4,500 ft (1,370 m) northeast of ground zero on the Area 3 fault. The BILBY event also cracked the Yucca fault with as much as 3 in. (8 cm) of downthrow on the east side, and created other prominent northwest to northeast fracture zones east of ground zero.

9. **National Geophysical Company, Inc., May-July 1964, Seismic survey report, second supplement, Nevada Test Site, Areas 3 & 7, Nye County, Nevada: Dallas, National Geophysical Company, Inc., submitted to U.S. Coastal and Geodetic Survey, unpaginated.**

This study builds on two previous studies by National Geophysical Company (Entries 1 and 4) with the addition of four seismic reflection lines to the north and three to the south. In the area of interest, on the map entitled "Structural Control for Horizon 'B,'" fault "A" is unchanged from the first supplement (Entry 4). Fault "B" was extended northeastward to 855,900N, 691,100E, and fault "D" was added to the east in the approximate location of the East Branch Area 3 fault. Fault "C" was extended northeastward and several short, unnamed fault segments were added. *Enclosure 1 (Structural Control for Horizon "A") could not be located.*

10. **Davis, R. E., July 1964, Summary maps of surface effects mapped in Yucca Flat, Nevada Test Site, January 1, 1964, through June 30, 1964: U.S. Geological Survey Technical Letter NTS-91, (Declassified July 31, 1989), 2 p.**

"Following each event since the beginning of 1964, the area surrounding the site was examined in detail, and fractures other than those that were probably the result of superficial compaction of loose material were recorded. In most instances the mapping was done at a scale of 1 inch equals 500 feet [1:6,000]. The summary maps at 1 inch equals 1,000 feet [1:12,000] are necessarily somewhat generalized, but the location, widths, and lengths of fracture zones are accurately shown."

Fractures can vary from "hairline cracks to fractures with separation of several inches" and such distinctions are not made on the summary maps. "Many if not most of the fractures mapped immediately following an event . . . probably have since been obliterated by sand and silt blowing over them or by machinery having passed across the areas. Even many of the fractures representing strong throughgoing structures such as the Yucca and Area 3 faults, have been obliterated since originally formed."

Near the Area 3 fault, new fracture zones shown on this map include: (1) those associated with U-3co (PIPEFISH; April 29, 1964; less than 20 kt [DOE, 1994]) west of U3bj and (2) a northeast-trending zone, about 1,500 ft (460 m) long, east of and parallel to the Area 3 fault between U3bp and U3bk that is probably related to U3bo (STURGEON; April 15, 1964; less than 20 kt [DOE, 1994]). The Area 3 fault is essentially unchanged from Williams' post-BILBY map (Entry 8). The gap between U3cs and the BANDICOOT fractures is represented by lines interspersed with question marks. The map accompanying this report shows "inferred faults from geophysical data," that apparently were transferred from National Geophysical Company's first Area 3 Supplement (Entry 4), but with no indication of downthrown sides. The fault transferred from National Geophysical's fault "B" parallels much of the Area 3 fault, but diverges northward near U3cs. The line transferred from fault "A" is shown as trending north-south through U3ax.

11. Williams, W. P., October 1964, Surface effects from underground tests at the U3cp and U3dl Sites, Yucca Flat, Nevada Test Site: U.S. Geological Survey Technical Letter NTS-96, 10 p.

Preceding the events at U3cp and U3dl (respectively, CANVASBACK; August 22, 1964; less than 20 kt; and HADDOCK; August 28, 1964; less than 20 kt [DOE, 1994]), the surrounding areas within a 2,640-ft (300-m) radius of each of the sites were examined, as were old fractures on the Area 3 fault. U3cp is located 1,500 ft (460 m) west of the Area 3 fault. New fractures formed continuously along the fault for a distance of 2,000 ft (610 m) as a result of the U3cp event. New fractures also formed at the U3cq site. A "strong system of north-trending fractures [occurred] 300 to 600 feet [90 to 180 meters] west of the Area 3 fault, or about 1,100 feet [335 meters] east of U3cp." "The relation, if any, of these fractures to the Area 3 fault is not clear at this time." The event at U3dl did not fracture the Area 3 fault; ". . . postshot [U3dl] examination [of the surface] did not disclose any new breaks on either the Yucca fault or the Area 3 fault." Neither U3cp or U3dl formed a collapse sink.

As a result of the U3cp event, fractures formed in and just west of "a trench" [USGS Trench D] about 500 ft (150 m) southwest of drill hole U7b. The fractures ". . . could not be traced north or south from the trench on the surface, nor did the fractures extend upward to the surface of the alluvium." *Williams states that the walls of the trench were unfractured prior to the U-3cp event. This statement conflicts with mapping results by Carr (Entry 16). Carr (1965) indicates that "a few inconspicuous, incipient cracks were noted in the trench walls." The conflict with Carr's mapping is probably not significant, although it should be noted.*

12. Williams, W. P., January 1965, Surface effects from an underground test at the U7b Site, Yucca Flat, Nevada Test Site: U.S. Geological Survey Technical Letter NTS-101, 6 p.

The event at U7b (AUK; October 2, 1964; less than 20 kt [DOE, 1994]) extended the Area 3 fault northward about 2,500 ft (760 m) from the preshot limit. The new fractures were north-south trending and formed in two en-echelon zones connected by a short, northeast-trending jog. The northern segment was reportedly the stronger and showed a 2-in (5-cm) down-to-the-east offset. This sense of offset is in contrast to earlier displacements on the Area 3 fault, which were primarily down to the west. The U7b site is on the east side of the Area 3 fault. USGS Trench D was caved in places by this event.

13. Emerick, W. L., March 1965, Surface effects from an underground test at the U3ct Site, Yucca Flat, Nevada Test Site: U.S. Geological Survey Technical Letter NTS-109, 6 p.

The event at U3ct (MERLIN; February 16, 1965; 10.1 kt [DOE, 1994]) did not affect the Area 3 fault significantly. One small fracture related to MERLIN, about 500 ft (150 m) southeast of drill hole U3ca, is on the Area 3 fault zone within the "gap" noted by Williams (1964) (Entry 8).

14. Williams, W. P., May 1965, Surface effects from an underground test at the U3an Site, Yucca Flat, Nevada Test Site: U.S. Geological Survey Technical Letter NTS-120, 8 p.

The Area 3 fault was examined before and after the test at U3an (WAGTAIL; March 3, 1965; 20-200 kt [DOE, 1994]). The U3an site is 9,000 ft (2,740 m) away from the Area 3 fault. The only effect was a 40-ft- (15-m)-wide zone of fractures along the Area 3 fault in a hard-packed cable west of U7b. Fractures were discontinuous, but traced for 1,000 ft (305 m) north and south of U7b. Away from the U7b site, the zone became single, discontinuous fractures found mostly in hard-packed, graded areas.

15. National Geophysical Company, Inc., April-June 1965, Seismic survey report, Nevada Test Site, Areas 1, 2, 3, 4, 5, 6, 8, and 7, Nye County, Nevada: National Geophysical Company, Inc., submitted to U.S. Coastal and Geodetic Survey, unpaginated.

In this study, additional reflection data were obtained in Areas 3 and 7. Objectives were to "determine the feasibility of mapping the Paleozoic surface in Yucca and Frenchman Flats by means of long-range refractions . . .", and ". . . study a small area located in Area 2 (Site 2-E of Project Discus Thrower) to determine if reflection techniques could here map the Paleozoic surface and depths of alluvium." The report summarizes results of all subsurface data obtained to date; results are presented by NTS area.

Reflections "A" and "B" are still mapped, but the authors no longer identify Reflection "A" as the base of the alluvium and state, "It is probable that this reflection originates from a welded tuff of the Piapi Canyon Formation." In light of the new study, ". . . data are somewhat altered from earlier reports. However, faults 'A' 'B' and 'C' are located much the same as reported before."

The northern ends of faults "B" and "C" (north of about N842,000) are now shown as dashed, because "faults 'B' and 'C' and the Yucca fault zone are poor in this area, as indicated on the map. The reflections on the east end of the lines are too shallow to map. The additional data have required new orientations of faults 'D' and 'E.'" faults "A," "B," and "C" are shown in this report to be connected to the Yucca fault at their southern ends. Fault "D," which was shown in the 1964 National Geophysical Company report (Entry 9) to be near the East Branch Area 3 fault, is now cut off far to the south (N821,750, E691,350). The northern end of fault "E" is now shown as trending northeast rather than northwest. All faults continue to be shown as downthrown to the east. *The Structural Control for Horizon "A" map (Enclosure 2) is apparently the source for the "subsurface fault zones inferred from seismic survey data" shown on the surface effects compilation map accompanying NTS-91, Supplement 3 (Entry 24).*

16. Carr, W. J., June 1965, Preliminary results of subsurface investigation of fractures in Yucca Flat, Nevada Test Site: U.S. Geological Survey Technical Letter Yucca-57, 15 p.

In August and September 1964, the USGS excavated five fault trenches in Yucca Flat. "The purpose of the trenches was to provide a three-dimensional view of explosion-produced and natural fractures and faults . . ." ". . . from which information might be obtained regarding their character and shallow vertical and linear extent." The objective was to establish a clear relation between the explosion-produced fracture and preexisting natural faults or fractures. [*This objective was not realized.*]

Regarding two of the trenches, ". . . the fourth [trench] (E) cut across a known zone of intense surface fractures; and the fifth [trench] (D) cut across the northward projection of the Area 3 fault beyond the area where it was marked by surface fractures." "Trench D ". . . is about 500 ft [152 m] southwest of the U7b site." "Trench E is located about 200 ft [61 m] north of the sink at U3bj, across the trace of the Area 3 fault." *Maps of each trench are included on a single sheet in the report.* "Prior to underground testing this [the Area 3] fault had no significant surface expression except for short distances. However, tests in Areas 3 and 7 have produced many surface fractures along this feature, some with as much as 4 inches [10.3 cm] of vertical displacement. The pattern of the surface fractures suggests a fairly complex fracture system that is grossly parallel to the Yucca fault zone (Davis, 1964). Events at the U7b and U3cp sites have extended surface fractures along this fault northward into Area 7." "It is certain that the fractures that were mapped on the surface at the time of the original postshot mapping have now been healed or filled by soft material within 5 or 10 ft [1.5 or 3.0 m] of the surface. . . "

When Trench D was excavated, a few inconspicuous, incipient cracks were noted in the trench walls. After the event at U3cp, numerous cracks with separation as much as 0.5 in. (1.3 cm) were readily visible near the west end of the trench. Additional new cracking was noted after a test at U9bd, 14,000 ft (4,270 m) away from Trench D. The fractures in Trench D were mostly in two zones, one on the west end, and one on the east end of the trench. Fractures at the western end had an average strike of about N10EW and dipped steeply westward. Fractures at the eastern end appeared to strike north or slightly east of north and dipped eastward. Roots were found in most of the cracks to depths as great as 20 ft (6 m). These roots were thought by Helen Cannon of the USGS to have grown into cracks formed in 1954 or 1955. Cracks could have formed at this time due to early testing or natural earthquakes. Trench D was caved primarily as a result of the event at U7b.

Study of Trench E was minimal because it caved rapidly due to the unconsolidated nature of the alluvium. Only minor fractures were observed in the trench and roots were not observed in these fractures.

17. Emerick, W. L., and Davis, R. E., August 1965, Surface effects mapped in Yucca Flat, Nevada Test Site, January 1, 1964. through June 30, 1965: U.S. Geological Survey Technical Letter NTS-91, Supplement 1, (Declassified July 31, 1989), 2 p.

This map, the second of three compilation maps by the USGS, shows fractures and "surface fault[s] inferred from seismic survey [source unknown]." Obvious changes in this map relative to NTS-91 (Entry 10) are the addition of an inferred surface fault and fractures between U3cs and the U3bj (BANDICOOT) fracture zone, and deletion of the question marks in this area. All but three of the fractures in this area appear to have been traced from lines with question marks on the BILBY postshot map (NTS-68) and NTS-91 (Entries 8 and 10). *Events at U3bx, U3dy, U3dw, or U3das seem the most likely cause of the remaining three fractures. The queried lines shown on the BILBY postshot map seem not to represent discrete fractures; rather, they serve to suggest a potential zone of weakness.* An additional change since the NTS-91 (Entry 10) is a fracture that will later be shown to be coincident with the East Branch Area 3 fault. *This fracture probably resulted from the Scaup event at U3das (Entry 22).*

18. Barosh, P., August 1965, Preliminary joint study of the northeast border of Yucca Flat and relationships of the joints to the pattern of surface effects produced over underground nuclear explosions: U.S. Geological Survey Technical Letter NTS-139, 19 p.

Barosh concluded that the common northeast trend of explosion-induced fractures in alluvium is sometimes related to the most pervasive set of throughgoing joints in the bedrock, and not to the youngest faults and joints underlying bedrock. On the map accompanying this report, Barosh drew lines of average trend through sets of fractures on the Area 3 fault and elsewhere. This makes the fault look less continuous than on previous maps. *For example, although the U3cq drill hole is usually drawn as a point on the trace of the Area 3 fault, the dominant fracture trend around U3cq (according to Barosh) is north-south and not parallel with the trace as usually drawn through this point.*

19. Morris, R. H., September 1965, Preliminary report of lineament studies of Yucca Flat Nevada Test Site, Nevada: U.S. Geological Survey Technical Letter NTS-140, 7 p.

The objectives of the study were to determine the geologic nature of the lineaments in the northern one-third of Yucca Flat and whether they have any special or casual relation to explosion-produced fractures. Lineaments he mapped included ". . . alignments of vegetation or stream channels, minor scarps, abrupt or systematic changes in drainage and other features . . . ". Morris used a series of 1:30,000-scale aerial photos flown in 1951, which predate any underground testing. Maps in the report ". . . show the lineaments superimposed on the surface effects maps (Emerick et al, 1965) to illustrate their relationship to explosion-produced [fractures]." The lineaments are plotted using two symbols, one representing lineaments without presently demonstrated structural relationships, and the other representing lineaments along which explosion fractures are present and which appear to be related to faults." "Some lineaments, particularly those which trend north-south, are fracturing as a result of underground explosions. Some lineaments are related to faults, others are coincident with or project into faults inferred from geophysical or other data." The maps show a ". . . persistent or inherent tendency for the explosion-produced fractures to have a northeasterly orientation."

"Few lineaments coincide with the strong northeasterly trend of fractures developed around many ground zeros." No lineaments coincide with the Area 3 fault as mapped from surface effects, except at the northern end of the fault near U7b. A significant feature of this map is a large curving "cracked lineament" to the east of the Area 3 fault. *This lineament will be defined later as the East Branch Area 3 fault.* Cracks shown on this curving lineament are concentrated around U3das (SCAUP site), but only one of these fractures is indicated on the map showing SCAUP surface effects in NTS-126 (Entry 22); therefore, the origin of the cracks is unknown. *Whether these fractures on the northern part prompted Morris to call the entire lineament cracked, or whether there were cracks along the entire lineament is unclear. In light of the lack of testing near the southern end of this lineament and the lack of any previously mapped fractures in this area, the former is probably the case.* The map accompanying this report shows faults from National Geophysical's first Area 3 Supplement (Entry 4). There is no geophysically inferred fault parallel to the cracked lineament, later called the East Branch Area 3 fault.

20. Ege, J. R., October 1965, Surface effects from an underground test at the U7g Site, Yucca Flat, Nevada Test Site: U.S. Geological Survey Technical Letter NTS-151, (Declassified August 4, 1989), 4 p.

The event at U7g (CHARCOAL; September 10, 1965; 20-200 kt [DOE, 1994]), located 2,000 ft (610 m) west of the northern extension of the Area 3 fault zone, did not produce any new fractures along the Area 3 fault. Although ground zero was on one of Morris' (Entry 19) "uncracked lineaments," no fractures were produced on this trend. The map in this report shows a "[s]ubsurface fault inferred from seismic survey," *possibly transferred from NTS-91 (Entry 10) or NTS-91 Supplement 1 (Entry 17).*

21. Corchary, G. S., January 1966, Surface effects from an underground test at the U3en Site, Nevada Test Site: U.S. Geological Survey Technical Letter NTS-159, 4 p.

The event at U3en (SEPIA; November 12, 1965; less than 20 kt [DOE, 1994]) was approximately more than 1,000 ft (300 m) west of the Area 3 fault segment originally noted as the "gap" between the BILBY fractures and the BANDICOOT fractures by Williams, 1963 (Entry 8). The event produced no fractures on any part of the Area 3 fault.

22. Emerick, W. L., March 1966, Surface effects from an underground test at the U3das Site, Nevada Test Site: U.S. Geological Survey Technical Letter NTS-126, 2 p.

The event at U3das (SCAUP; May 14, 1965; less than 20 kt [DOE, 1994]) formed a crater 670 ft (205 m) in diameter and 12 ft (4 m) deep, and tangential surface fractures as far as 2,000 ft (610 m) from surface ground zero. A surface-effects map shows tangential fractures associated primarily with the U3das crater, north-northwest fractures west of the crater, and northwest trending fractures southwest of the crater. The north-northwest and northwest trending fractures together extend for about 1,600 ft (490 m) along the Area 3 fault approximately between N840,000 and N842,000. The effects map also shows a single fracture, about 250 ft (75 m) long, 60 to 120 ft (20 to 40 m) west of the "cracked lineament" of Morris (Entry 19) that later became the East Branch Area 3 fault.

23. Corchary, G. S., and Barnes, H., April 1966, Surface effects mapped in Yucca Flat, Nevada Test Site, through March 1, 1966: U.S. Geological Survey Technical Letter NTS-91, Supplement 2, 4 p.

Little change is evident along the Area 3 fault zone between NTS-91, Supplement 1 (Entry 17) and this map. Fractures on the East Branch Area 3 fault are shown near the single fracture mapped in NTS-126 as caused by the SCAUP event (Entry 22). These are the same fractures shown by Morris (Entry 19), and their origin remains unclear. Events since NTS-91, Supplement 1 include CHARCOAL at U7g and SEPIA at U3en (Entries 20 and 21), neither of which affected the Area 3 fault. This map also shows "subsurface faults as inferred from seismic survey" and Morris' lineaments (Entry 19). The subsurface faults are derived from the latest National Geophysical Company report (Entry 15) and are slightly different from those shown on the map accompanying Supplement 1. The main difference is that the three main faults east of the Yucca fault are now shown as joined to the Yucca fault at their southern ends, and the easternmost fault has been deleted. From April 1966 to July 1966 a series of short reports (NTS-91, Supplements 2a through 2o) was released. These are surface effects reports for individual events. The events closest to the Area 3 fault are at U3cd and U3du, both approximately more than 2,000 ft (610 m) away from the southern end of the mapped trace. Neither of these events affected the Area 3 fault.

24. Corchary, G. S. and Barnes, H., July 1966, Surface effects mapped in Yucca Flat, Nevada Test Site, through June 30, 1966: U.S. Geological Survey Technical Letter NTS-91, Supplement 3, (Declassified July 31, 1989), 4 p.

The map shows the same three "subsurface faults as inferred from seismic data" connected to the Yucca fault as in Supplement 2 (Entry 23), and shows them as all being down to the east. No new fractures since Supplement 2 are shown on this map near the Area 3 fault. One new collapse sink is shown at U3du, about 2,200 ft (670 m) west of the south end of the Area 3 fault.

25. McKeown, F. A., and Dickey, D. D., May 1967, Map of explosion-produced fractures in Yucca Valley, Nevada Test Site: U.S. Geological Survey Technical Letter NTS-195, 4 p.

The map is a compilation of all surface effects mapped between September 1963 and April 1967. "Fractures produced by most of the underground nuclear explosions have been mapped in various amounts of detail by many geologists; hence the style and detail of the mapping vary from place to place on the map. Between September 1963 and July 1996, the fractures produced by all explosions were mapped. Since July 1966, only the fractures of selected explosions have been mapped."

The map, near the Area 3 fault, closely resembles the map in NTS-91, Supplement 3 (Entry 24).

26. Fernald, A. T., Corchary, G. S., and Williams, W. P., October 1967, Thickness of surficial deposits in Yucca Flat, Nevada Test Site: U.S. Geological Survey Technical letter NTS-194, 2 p.

The report includes an isopach map of alluvium (Plate 5) that is a revision of an earlier map by Chase (1965), and a structure contour map of the base of the alluvium. The forked trace of the Area 3 fault is dashed on both maps. No relative motion is indicated. *Contours at the trace suggest a down-to-the-east sense of motion.*

27. Fernald, A. T., Corchary, G. S., and Williams, W. P., 1968, Surficial geologic map of Yucca Flat Nye and Lincoln Counties, Nevada: Miscellaneous Geologic Investigations Map I-550, scale 1:48,000.

The forked trace of the Area 3 fault is shown on this map as a dashed line representing "fault or lineament . . . indefinite or approximately located. Commonly occurs as a crack."

28. Healey, D. L., 1968, Application of gravity data to geologic problems at Nevada Test Site, *in* Eckel, E. B., (ed.), Nevada Test Site: Geological Society of America Memoir 110, p. 147-156.

The report provides little information not previously presented in Healey, D. L., March 1963, Correlation of gravity data and faulting in Yucca Flat, Nevada Test Site: U.S. Geological Survey Technical Letter Yucca-43, 11 p. (Entry 5).

29. Dickey, D. D., 1968, fault displacement as a result of underground nuclear explosions, *in* Eckel, E. B., (ed.), Nevada Test Site: Geological Society of America Memoir 110, p. 219-232.

"The Area 3 fault is located about 1.5 mi (2.4 km) to the east of the Yucca fault in the middle of the valley (Yucca Flat) . . . and trends about N10E E." "A weathered west-facing scarp about 2 ft (0.6 meters) high occurs at some places along the fault, but elsewhere the fault has no noticeable surface relief." "This fault displacement is the result of displacement in the bedrock and does not merely reflect differential compaction of the overlying alluvium." Second to the Yucca fault, "The Area 3 fault is the next most sensitive (to show displacement resulting from underground explosions) and will register displacement if the scaled distance is less than 500 (using the equation $S=D/W^{1/3}$, where S is the scaled distance, D is the minimum horizontal distance, in feet, between the explosion and the surface trace of the fault, and W is the yield of explosive, in kilotons equivalent TNT.)"

"Possible explanations for fault displacements" . . . (A) Explosion-produced stress added to the existing stress field is sufficient to exceed the force of static friction along the fault plane; (B) The vibrations produced by the explosions may reduce friction along the fault, thereby reducing the amount of stress required to cause displacement, and the existing stress field causes the displacement; and (C) A combination of mechanisms (A) and (B) cause displacement."

30. Barosh, P. J., 1968, Relationships of explosion-produced fracture patterns to geologic structure in Yucca Flat, Nevada Test Site, *in* Eckel, E. B., (ed.), Nevada Test Site: Geological Society of America Memoir 110, p. 199-218.

The report provides little information not previously presented in Barosh, P., August 1965, Preliminary joint study of the northeast border of Yucca Flat and relationships of the joints to the pattern of surface effects produced over underground nuclear explosions: U.S. Geological Survey Technical Letter NTS-139, 19 p. (Entry 18).

31. Fernald, A. T., 1970, Thickness of Surficial Deposits and Tuff in Yucca Flat, Nevada Test Site: U.S. Geological Survey Report NTS-224 (USGS-474-86), 9 p.

The report includes: (1) a revised isopach map of surficial deposits *[originally issued in 1965 as Technical Letter NTS-136, by Livingston Chase]*, and (2) a structure contour map of the base of Cenozoic rocks derived from drill hole and gravity data. The Area 3 fault is shown to be displaced down to the east. *Compare this report with Hazlewood, R. M., Healey, D. L., and Miller, C. H., April 1963, U.S. Geological Survey investigations of Yucca Flat, Nevada Test Site, Part B–geophysical investigations: U.S. Geological Survey Technical Letter NTS-45, 53 p. (Entry 6).*

32. McKeown, F. A., Bucknam, R. C., Dickey, D. D., and Snyder, R. P., 1971, Summary of geologic structural information relative to noncontained and contained nuclear explosions: U.S. Geological Survey Administrative Report, 71 p.

Venting of the BANDICOOT event at U3bj is assumed to have been from a fracture trending N10E-15EE that passed near ground zero. Also mentioned is a 140-ft- (45-m-) wide zone of fractures extending N10EE for about 1,600 ft (490 m) from U3bj (Entry 2). The authors recognize the test as having been in or very close to the Area 3 fault zone. "A seismic survey by the National Geophysical Company indicates not only the presence of the Area 3 fault at depth but another fault 1,300 ft (400 m) west of the U3bj site . . . . The seismic survey data, which seem valid, conflict with surface evidence of the direction of displacement on the Area 3 fault; about 5,000 ft (1,524 m) north of where the survey was conducted surface evidence shows that the west side of the fault is down. The seismic survey shows the east side down. This contradictory information suggests that perhaps more than one fault is involved. The direction of displacement along most faults does not change; change in direction, however, is not rare. Because of the continuity of the fracturing along the Area 3 fault, we interpret it as one fault zone with changes in displacement along it."

The event at U3cy (PIKE, March 13, 1964; less than 20 kt [DOE, 1994]) vented along an open fissure about 25 ft (8 m) long trending about N15EE, parallel to the Area 3 fault. U3cy is about 2,000 ft (610 m) from the Area 3 fault zone, which apparently was not affected. The event at U3bz (GRUNION; October 11, 1963; low yield [DOE, 1994]) and the event at U7y (TIJERAS; October 14, 1970; 20-200 kt [DOE, 1994]), both of which were contained, are discussed as analogs for the BANDICOOT event. U3bz (GRUNION) is about 750 ft (230 m) south of U3bj (BANDICOOT) and is also thought to be within the Area 3 fault zone. The TIJERAS event was detonated within a fracture zone caused by the Auk event (U7b). "Tijeras caused extension of the zone for a length of at least 5,000 feet [1,524 m] to the southeast and displacements of as much as 12 in. (9 cm) down on the west side." The reasons that these events did not vent, while BANDICOOT and PIKE did, are not fully understood.

33. Snyder, R. P., and Rogers, S., 1972, Explosion-induced surface fractures of selected announced underground nuclear tests, Yucca Flat, Nevada Test Site, Nevada, October 1969 through December 1970: U.S. Geological Survey Report NTS-231 (USGS-474-133), 57 p.

The report discusses 17 underground nuclear tests conducted between October 29, 1969, and December 31, 1970, and maps the surface effects of these tests. Two tests affected the Area 3 fault: U7s (GRAPE [A]; December 17, 1969; 20-200 kt [DOE, 1994]) and U7y (TIJERAS) (Entry 32). GRAPE (A), located about 2,700 ft (820 m) east of the northern part of the Area 3 fault zone, reactivated the Area 3 fault from 2,500 ft (760 m) west-southwest to 3,500 ft (1,070 m) of ground zero; movement was both renewed and new.

The event at U7y (TIJERAS) reactivated the Area 3 fault, 1,300 to 1,400 ft (400 to 430 m) west of ground zero, for a length of 4,600 ft (1402 m). Fracturing west of the Area 3 fault was restricted to a 400-ft- (120-m-) long pressure ridge 800 ft (245 m) west of the fault. East of the crater, a 1000-ft- (305-m-)-wide zone of fractures fans out to the east. The zone may cross the crater to the west, where it appears as a single fracture that curves north into the Area 3 fault. The southern end of the zone of new fractures had an offset in one place of 8 in. (20 cm) down to the west. Offset of up to 9 in. (23 cm) down to the east occurred about 2,000 ft (610 m) north of this scarp. A prominent scarp trending southeast from ground zero was later named the 7y fault. The compilation map accompanying this report is the first to show a solid line (denoted as "fault showing explosion-induced movement" in the map legend) averaged through the Area 3 fault zone. A gap of about 1,000 ft (305 m) northeast of U3cq was bridged by this line. The geophysically inferred faults were not included on this map, and Morris' lineaments (Entry 19) also were dropped except for one "cracked lineament." The designation of Morris' cracked lineament was changed to "fault showing explosion-induced movement," and the southern end of this lineament was shortened about 2,000 ft (610 m). A dashed line was then drawn from the new endpoint near U3fj through fractures probably from U3ez and/or U3gz to a northeasterly trending fracture zone near U3dg. The resulting line was named the East Branch Area 3 fault, and a short dashed line was added to connect this branch to the Area 3 fault trace.

34. Steele, S. G and Snyder, R. P., 1973, Explosion-induced fractures of selected announced underground tests, Yucca Flat, Nevada Test Site, Nevada, January through December 1972: U.S. Geological Survey Report NTS-245 (USGS-474-176), 38 p.

During the time period covered by this report, the event at U3jq (MONERO, May 19, 1972, less than 20 kt [DOE, 1994]), was the only test near the Area 3 fault. MONERO ground zero is located about 1,250 ft (380 m) east of the East Branch Area 3 fault. This event reactivated the 7y fault, but did not affect the Area 3 fault or the East Branch Area 3 fault. A map of explosion-induced features accompanying this report shows the same forked trace of the Area 3 fault and East Branch Area 3 fault as in USGS-133 (NTS-231) (Entry 29).

35. Carr, W. J., 1974, Summary of tectonic and structural evidence for stress orientation at the Nevada Test Site: U.S. Geological Survey Open-file Report 74-176, 53 p.

The general structural character of Yucca Flat is interpreted using multiple lines of evidence. In reference to the trough bounded on the west side by the Yucca fault, "Several west-dipping faults, such as the Area 3 fault, form the east walls of the medial trough, but basically the east side of the trough is a downwarp." "The Tertiary rocks dip westward into the basin from outcrops along the east side of the valley. Dips and strikes obtained from scattered drill holes in Areas 3 and 6 indicate that a westward dip in the tuffs persists into the main deep trough east of the Carpetbag fault zone." This information should be considered when interpreting drill hole data because a westward dip on a surface between two drill holes may be indistinguishable from a down-dropping of the surface to the west.

36. Seisdata Services, Inc., 1980, Los Alamos Scientific Lab seismic lines, Seisdata Services, Inc., unpaginated.

Data from six seismic lines run by Seisdata for Los Alamos Scientific Lab in 1980 were located. Lines 6 and 2 are within the area of interest to this study. An accompanying interpretive report has not been located.

37. Ferguson, J. F., 1981, Geophysical investigations of Yucca Flat: Dallas, Southern Methodist University, Ph.D. Dissertation, 110 p.

Three seismic lines were recorded by Ferguson and Western Geophysical in 1978. One of these, Line E-3, runs east to west across Yucca Flat roughly 1.0 m (0.6 km) south of the Area 3 RWMS. Interpretation of data was aided by gravity and borehole data. The Area 3 fault is not specifically mentioned; however, several faults are shown in the general area south of the mapped traces. "West-dipping faults on the eastern end of the seismic lines have steep dips, on the order of 70 degrees, and are conjugate to the basin forming faults." In contrast, Ferguson interprets the Carpetbag and Yucca faults to be shallow-dipping (45E to 60E) faults with a combination of right-lateral and dip slip. *The interpretation of the faults in the eastern basin as west-dipping (suggesting west sides down if they are normal faults) is in contrast to the National Geophysical Company's conclusion that the Area 3 and other faults in this area are down to the east.*

38. Dockery-Ander, H. A., 1984, Rotation of Late Cenozoic extensional stresses, Yucca Flat region, Nevada Test Site, Nevada: Houston, Rice University, Ph.D. Dissertation, 77 p.

The report does not specifically mention the Area 3 fault, although the trace is superimposed on the accompanying isopach and structure contour maps. Dockery used ". . . data from more than 300 drill holes . . . to construct isopach and structure contour maps of major Tertiary and Quaternary units . . . " and found ". . . no evidence . . . for the presence of major faults other than the Yucca and Carpetbag."

39. App, F. N., 1985, Permanent displacement of the ground surface resulting from underground-nuclear-test-induced ground shock, *in* Olson, C.W. and Donohoe, M.L., (eds.), Proceedings of the Third Symposium on Containment of Underground Nuclear Explosions, v. 2: Idaho Falls, ID, U.S. Department of Energy, p. 409-425.

The surface effects of four events, including the event at U7bd (PALIZA; October 1, 1981; 20-150 kt [DOE, 1994]), were studied in detail with the aid of surveyed level lines. Site U7bd is located approximately 500 ft (150 m) east of the northern part of the Area 3 fault and about the same distance to the west of the U7y fault. Offsets of up to 5 in. (10 cm), down to the west, were observed where crack mapping had indicated no fractures. Upon closer inspection, minor cracking was discovered at the sites of the measured offsets, but no cracking was seen at a third site where the level line had been offset by 2.5 in. (6.4 cm). App concludes that ". . . standard crack mapping does not always pick up indications of fault motion at the surface." This study also provided evidence that a large structural block between the Area 3 fault and another fault near the east end of the line was rotated to the east. A surface effects map was not included with this report.

40. Drellack, S. L., Jr., 1994, Structure contour map of the top of the Rainier Mesa Tuff in LANL use areas, Yucca Flat, NTS, revision 3: LANL Geologic Support Group Map TMRSC1.DGN, scale: 1:24,000.

This map is one of a series of structure contour maps on various stratigraphic surfaces. This map is based on a complete and current set of borehole data. The subsurface fault is interpreted as having the shape of the surface trace (as defined by the persistent trend of shot-induced surface fractures) and is offset to the west by an amount based on depth to the contoured horizon and an assumed dip. This interpretation fits the subsurface drill hole data, although there are relatively few data points near the southern end of the Area 3 fault where it approaches the Area 3 RWMS. *Two data points, however, may provide evidence of offset of the top of the Rainier Mesa Tuff of the Timber Mountain Group. Roughly 3,000 ft (915 m) north of the Area 3 RWMS, drill holes U3cs and U3kx show elevations of the top of the Timber Mountain Tuff of 3,183 and 2,900 ft (972 and 885 m), respectively. This is an offset of 287 ft (83 m) in a lateral distance of less than 1,250 ft (380 m). The offset can be explained by faulting down to the west or by a surface dipping about 13EW. Tertiary rocks in outcrops roughly 2 mi (3 km) to the east dip 5 to 15EW.*

41. USGS, 1990, Surface effects compilation map: Unpublished compilation map, scale 1:12,000.

An unpublished compilation map has been maintained by the U.S. Geological Survey. This map shows the fractures associated with post-1975 events in addition to previously mapped fractures. Near the Area 3 fault, the map shows a collapse sink and minor fracturing associated with the event at U3kx (CANFIELD; May 2, 1980; less than 20 kt [DOE, 1994]), just southeast of BILBY (U3cn), but fracture patterns on the segment of the Area 3 fault nearby appear unchanged from previous published maps. Near the northern part of the Area 3 fault, two collapse sinks are shown on this unpublished map which postdate previous mapping. These are U7bd (Entry 39) and U7bp (ATRISCO; August 5, 1982; 138 kt [DOE, 1994]). These events have added more fractures to the adjacent Area 3 fault without extending it farther north.

REFERENCES

Chase, L., 1965. Revised isopach map of alluvium in Yucca Flat, Nevada Test Site: U.S. Geological Survey Technical Paper NTS-136, 1 p., 1 map sheet, scale 1:48,000.

Dixon, G. L., Sargent, K.A., and Spengler, R.W., 1973. Lithologic logs of exploratory and emplacement holes in Area 3, Nevada Test Site: U.S. Geological Survey Report NTS-244 (USGS-474-151), 138 p.

DOE, 1994. United States nuclear tests July 1945 through September 1992: Department of Energy Report DOE/NV-209 (Rev. 14), paginated by section.

Drellack, S. L., Jr., and Thompson, P.H., 1990. Selected Stratigraphic data for drill holes in LANL use areas of Yucca Flat: Department of Energy Report DOE/NV/10322-39, 192 p.

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APPENDIX B
TRENCH WALL MAPS

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LEGEND AND DESCRIPTION FOR TRENCH MAPS AND DETAIL MAPS

SYMBOL/PATTERN LEGEND

AREA OF DETAIL MAP

UNCEMENTED AREA WITHIN A CHARACTERISTICALLY WELL-CEMENTED AREA

GRAVELLY ZONE

GENTLY DIPPING CHANNEL BOTTOM

HIGHLY FRACTURED ZONE

ZONE OF DIFFUSE CARBONATE CEMENTATION IN FAULT ZONE

COVERED AREA (BENCH, SPOIL)

LARGE PEBBLE

ALIGNED PEBBLES

OPEN FRACTURE

1,2 30° FRACTURE WITH BEARING MARKED-NUMBERS REFERENCE FRACTURE DESCRIPTIONS

STRONG LAMINAR OR PLATY CARBONATE ZONE

* INDICATES CORRESPONDING HORIZONS ACROSS A FRACTURE THAT MAY BE OFFSET

S2, S3...S7 GEOMORPHIC SURFACE DESIGNATION

L, M, N, W, X, Y, Z ALLOFORMATION DESIGNATIONS

X1, X2...W2 ALLOMEMBER DESIGNATIONS

CONTACT LEGEND

MINOR DISCONTINUITY

LITHOFACIES CONTACT

ALLOMEMBER CONTACT

ALLOFORMATION CONTACT

TOP/BOTTOM OF TRENCH

BENCH TOP

LATERAL GRADATIONAL CONTACT

NOTE:
LINES DASHED WHERE INDISTINCT
LINES QUERIED WHERE INFERRED

FRACTURE DESCRIPTIONS

1 Hairline fracture or fracture with opening less than 0.08 in (2mm) (small crack).

1a Open fracture with opening greater than 0.08 in (2mm). Open fracture may have been filled with loose material that fell out after trenching.

2 Plane of preferential growth of modern roots.

3 Thin [less than 0.08 in (2 mm)], near-vertical or vertical calcium carbonate lamina.

3a Laminar zone greater than 0.08 in (2 mm).

4 Near-vertical zone of diffuse calcium carbonate.

5 Rhizolith along planar zone.

6 Planar zone filled with alluvium/colluvium that is softer than the adjacent horizon.

7 Fracture showing offset of bedded planes or soil horizons.

8 Fracture with clasts rotated into fracture plane.

9 Fracture that trends upward into channel margin.

10 Zone of fractures too closely spaced to show at map scale.

DESCRIPTIONS OF UNITS USED ON DETAIL MAPS (1)(4)

TRENCH ST02 (Applies to Figure B-3)

X2d/b1	Loose channel gravels and poorly sorted pebbly sands.
X2d1	Slightly hard to hard channel gravel, moderately sorted and bedded, capped by a 0.04-in (1-mm) thick carbonate lamina; east of station 0+7.5 ft, X2d1 is an unsorted, unbedded, silty sandy gravel with abundant large pebbles and few cobbles.
X1a1	Pebbly sand with hard angular blocky structure near top grading to loose below, abundant rhizoliths, Stage I+ carbonate(3), may have cobbles, especially near top.
W2a1	Carbonate-cemented sandy gravel, Stage III carbonate(3) at top decreasing with depth; wavy upper contact with 0.04-in (1-mm) lamina; no significant laminae or ooliths (globules) within unit; capped by a sand layer, in places, 0.4 to 0.8 in (1 to 2 cm) thick with platy structure that may be correlative with sandy, platy cap on W2d/e1.
W2d/e1	Hard to extremely hard sand with gravel increasing with depth, Stage III carbonate(3), platy near top with carbonate filaments, angular blocky structure below; silica and carbonate coats on clasts up to 0.08 in (2 mm) thick, diffused ooliths (globules); due to hardness of unit, clasts were broken off, rather than plucked out, during excavation of trench.
W2b1	Loose lenses within W2.
W1a1	Well-cemented sandy gravel, capped by silica laminae with an irregular, sometimes "troweled" surface; extremely hard, but with loose lenses; carbonate and silica coats on clasts up to 0.2 in (5 mm) thick, stringers of ooliths (globules) common.

TRENCH ST03 (Applies to Figure B-5 and Figure B-7)

N2j2	Slightly hard silt and very fine sand.
N2j1	Sand and silty sand; channel deposits.
N1a1	Similar to N2j1, but separated from N2j1 by a BA(2) soil horizon characterized by pores and fine platy structure.
N1a2	Slightly hard to hard silt and very fine sand with coarse [greater than 1 ft (0.3 m)] prismatic structure; forms a ledge.
N1a3	Bedded coarse sand.
N1b/d2	Bedded silt and fine sand.
N1b/d1	Loose, pebbly sand, mostly unbedded, with scattered, slightly hard, subangular blocky structure.
Ma/b1	Pebbly sand with abundant hard prisms 0.1 to 0.2 ft (0.03 to 0.06 m) in size; some loose lenses, mottled appearance.
La/b4	Well-cemented pebbly sand with mottled appearance.
La/b3	White, extremely hard carbonate-cemented gravelly sand; may be areas of preferential cementation and not a strictly stratigraphic unit.
La/b2	Buried argillic soil horizon, hard, angular blocky structure, clay films, carbonate filaments.
La/b1	Loose sandy gravel Ck(2) horizon underlying other soil horizons of Allomember L; indistinctly bedded with occasional moderately carbonate-cemented beds.

(1) See text, Section 4, for discussion of units.
(2) Soil horizon nomenclature after Birkeland, 1984.
(3) Carbonate stages after Gile and others, 1966.
(4) See Snyder, et al. (1993) for description of lithofacies.
(5) Geomorphic surfaces not mapped in Trench ST03 due to disturbed surfaces.

Figure B-1

SKETCH NUMBER
SK-003-97-EM119

PREPARED BY
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SHEET 1 of 1

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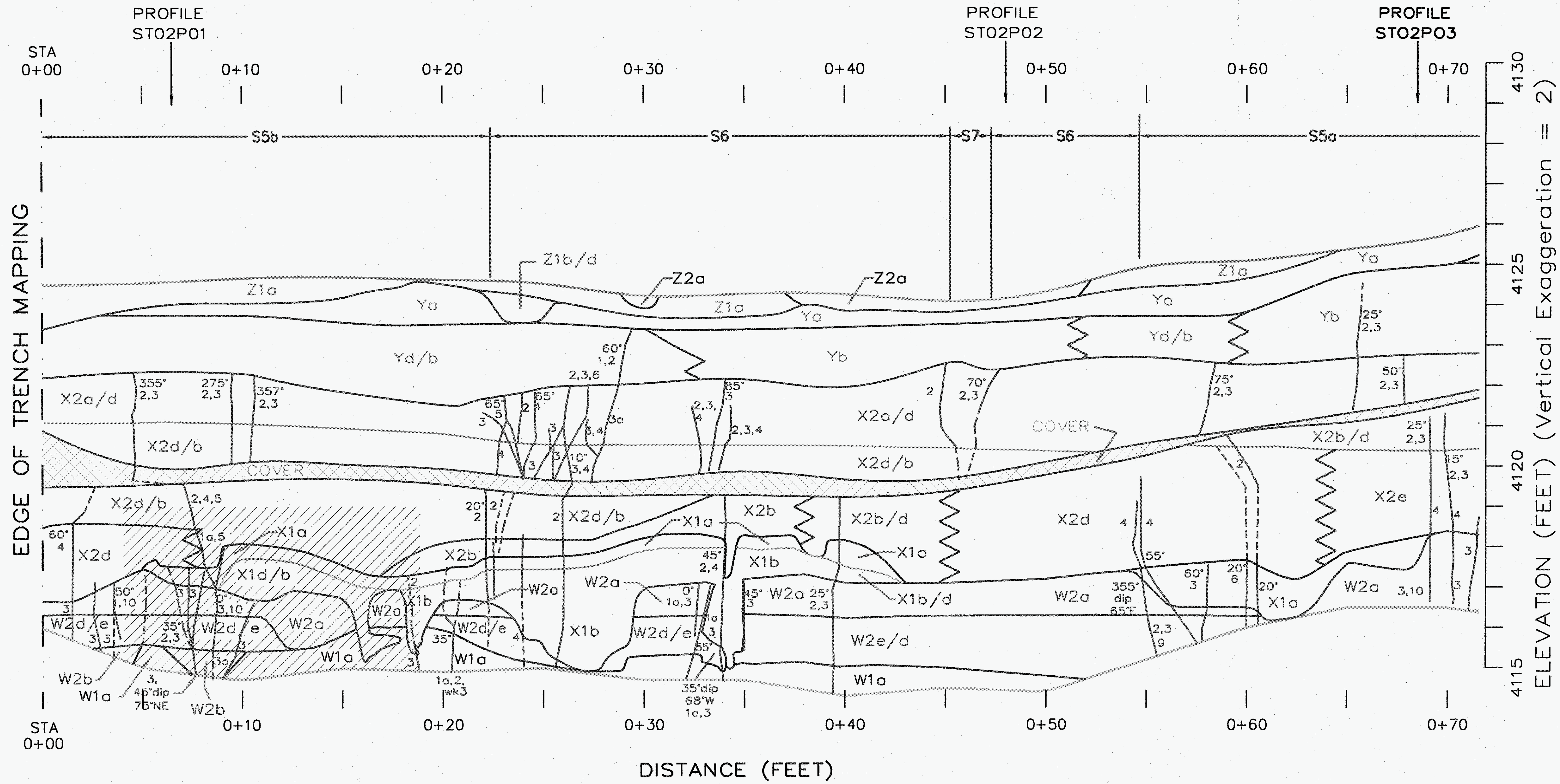

Figure B-2a

SKETCH NUMBER SK-003-97-EM105

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STRATIGRAPHY AND GEOMORPHIC SURFACES OF NORTH WALL IN SOIL TRENCH TWO (ST02) SOUTHEASTERN YUCCA FLAT

SHEET 1 of 4

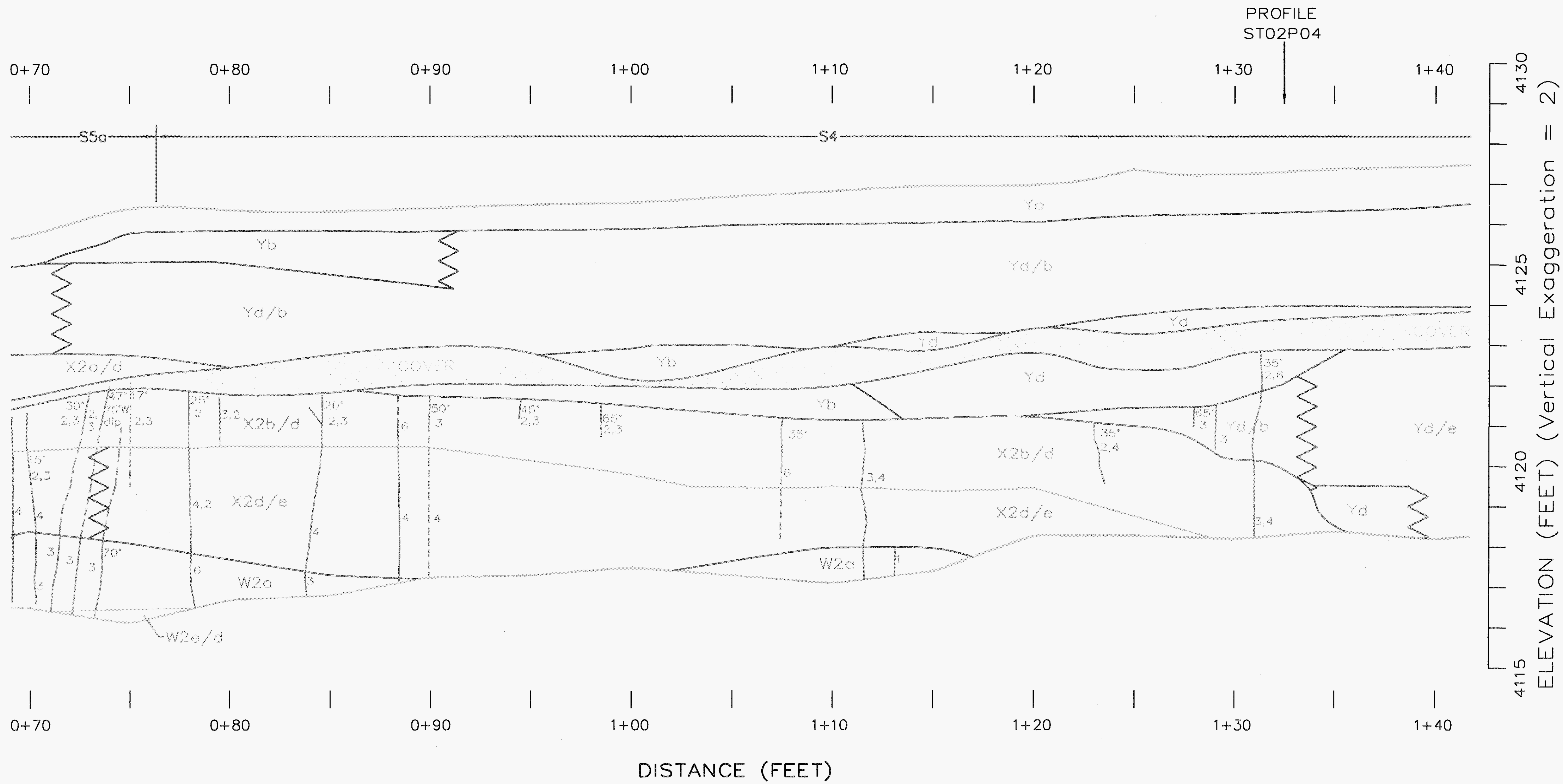

Figure B-2b

STRATIGRAPHY AND GEOMORPHIC SURFACES OF NORTH WALL IN SOIL TRENCH TWO (ST02) SOUTHEASTERN YUCCA FLAT

SHEET 2 of 4

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PREPARED BY
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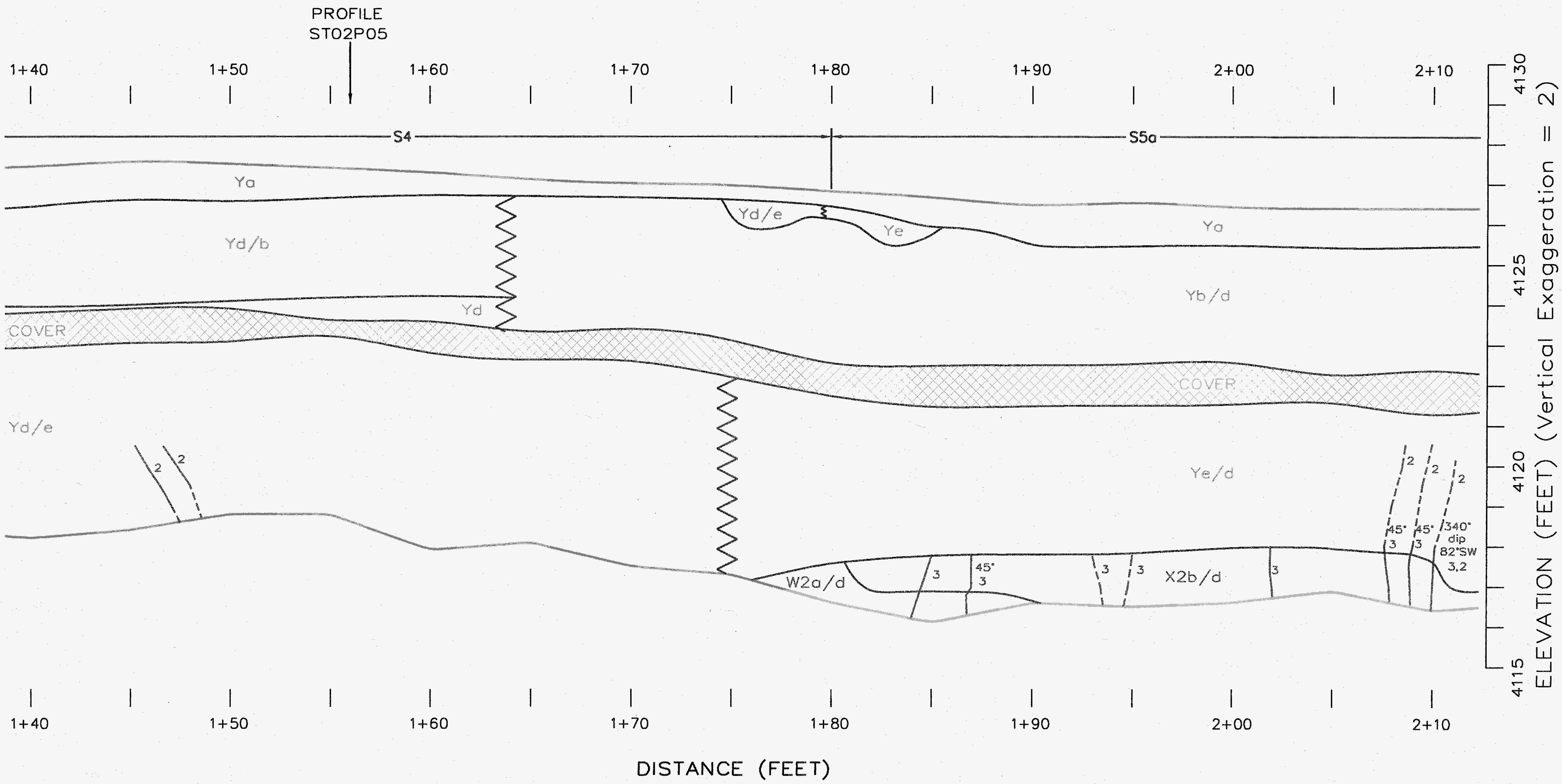

Figure B–2c

STRATIGRAPHY AND GEOMORPHIC SURFACES OF NORTH WALL IN SOIL TRENCH TWO (ST02) SOUTHEASTERN YUCCA FLAT

SHEET 3 of 4

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PREPARED BY
National Security Technologies LLC
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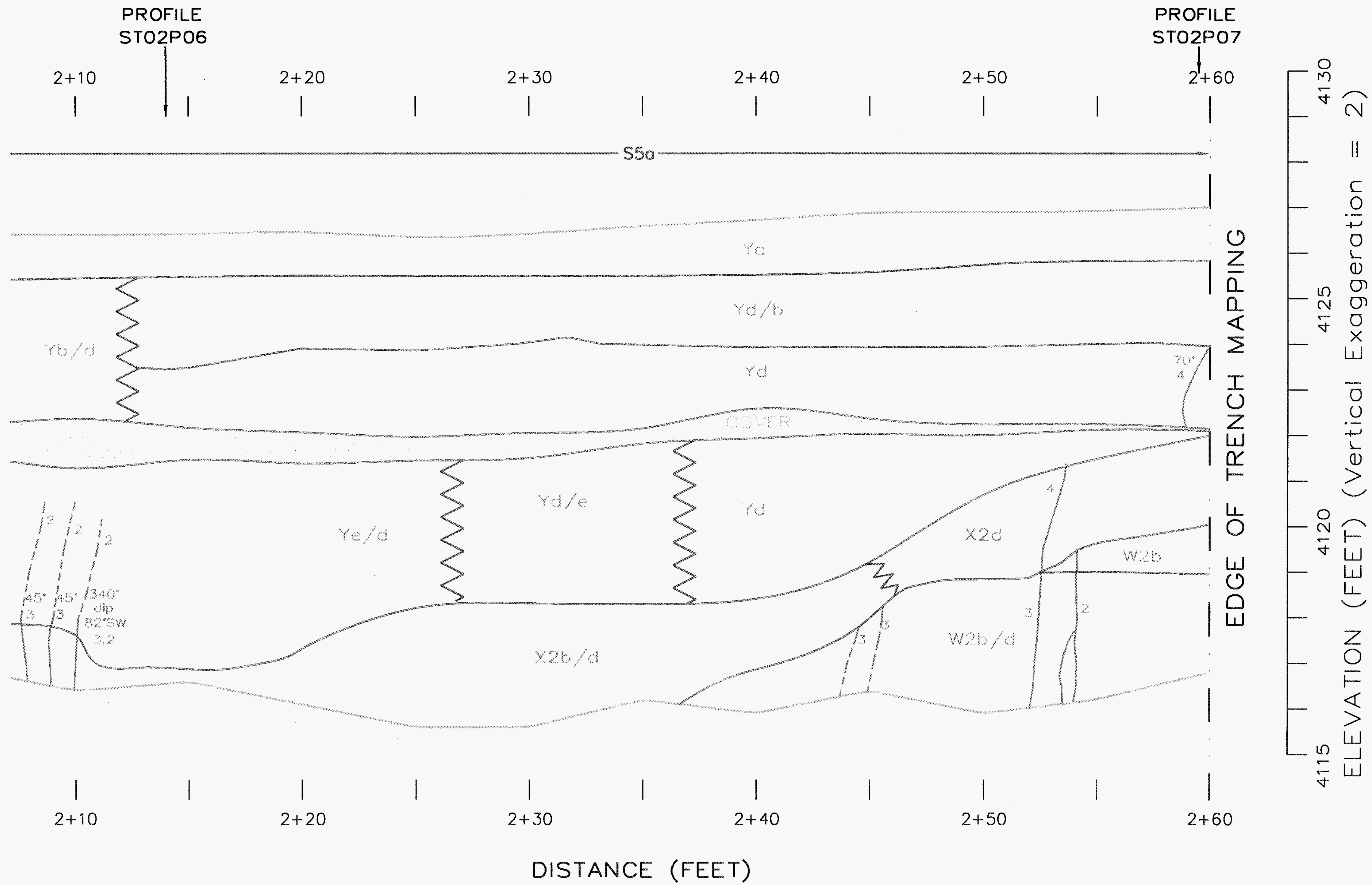

Figure B-2d

STRATIGRAPHY AND GEOMORPHIC SURFACES OF NORTH WALL IN SOIL TRENCH TWO (ST02) SOUTHEASTERN YUCCA FLAT

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PREPARED BY
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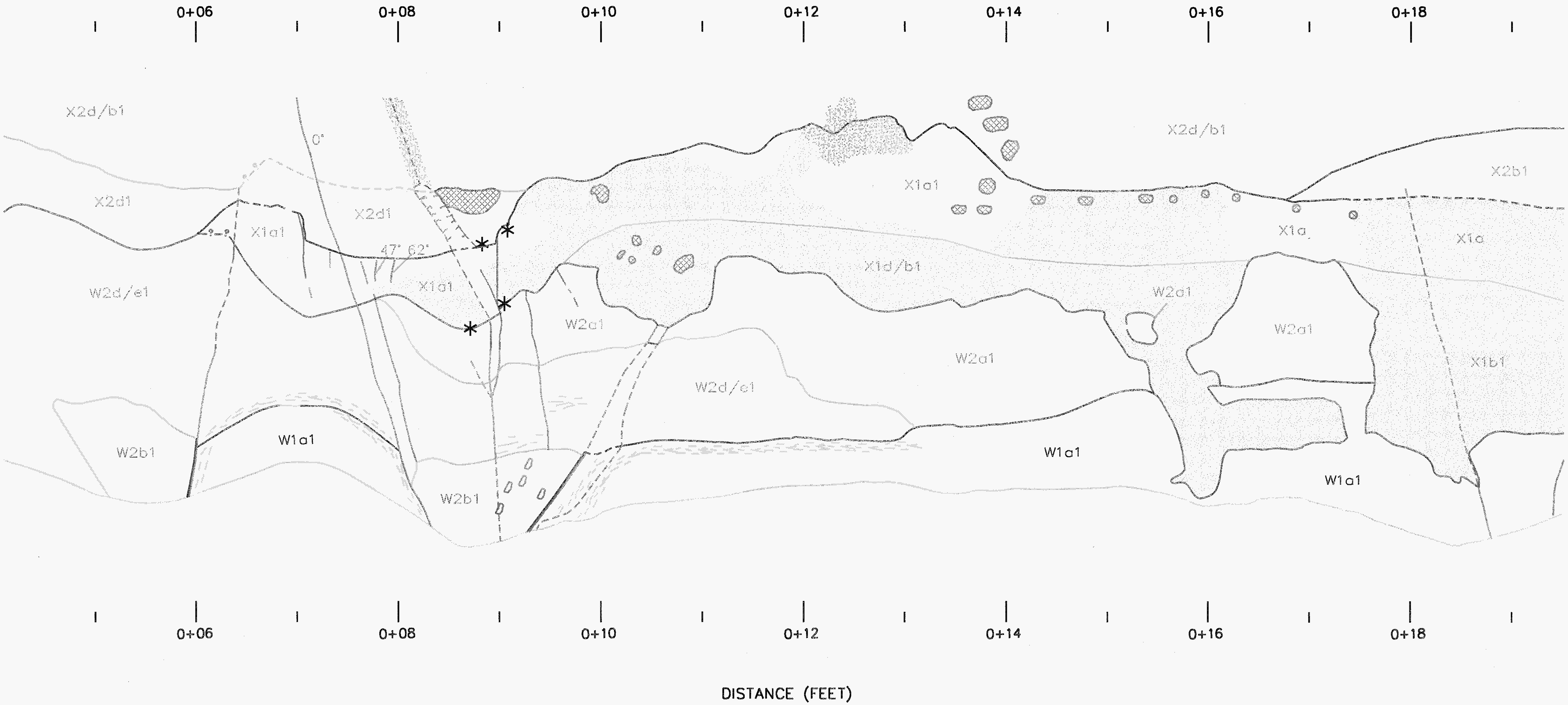

SCALE: 1 inch = 1 foot

0 1 2 (feet)

SHEET 1 of 1

DETAIL MAP OF FRACTURE ZONE BETWEEN STATIONS 0+04 AND 0+20, LOWER LEVEL OF TRENCH ST02 (Refer To Figure B–2a)

Figure B–3

SKETCH NUMBER SK-003-97-EM109

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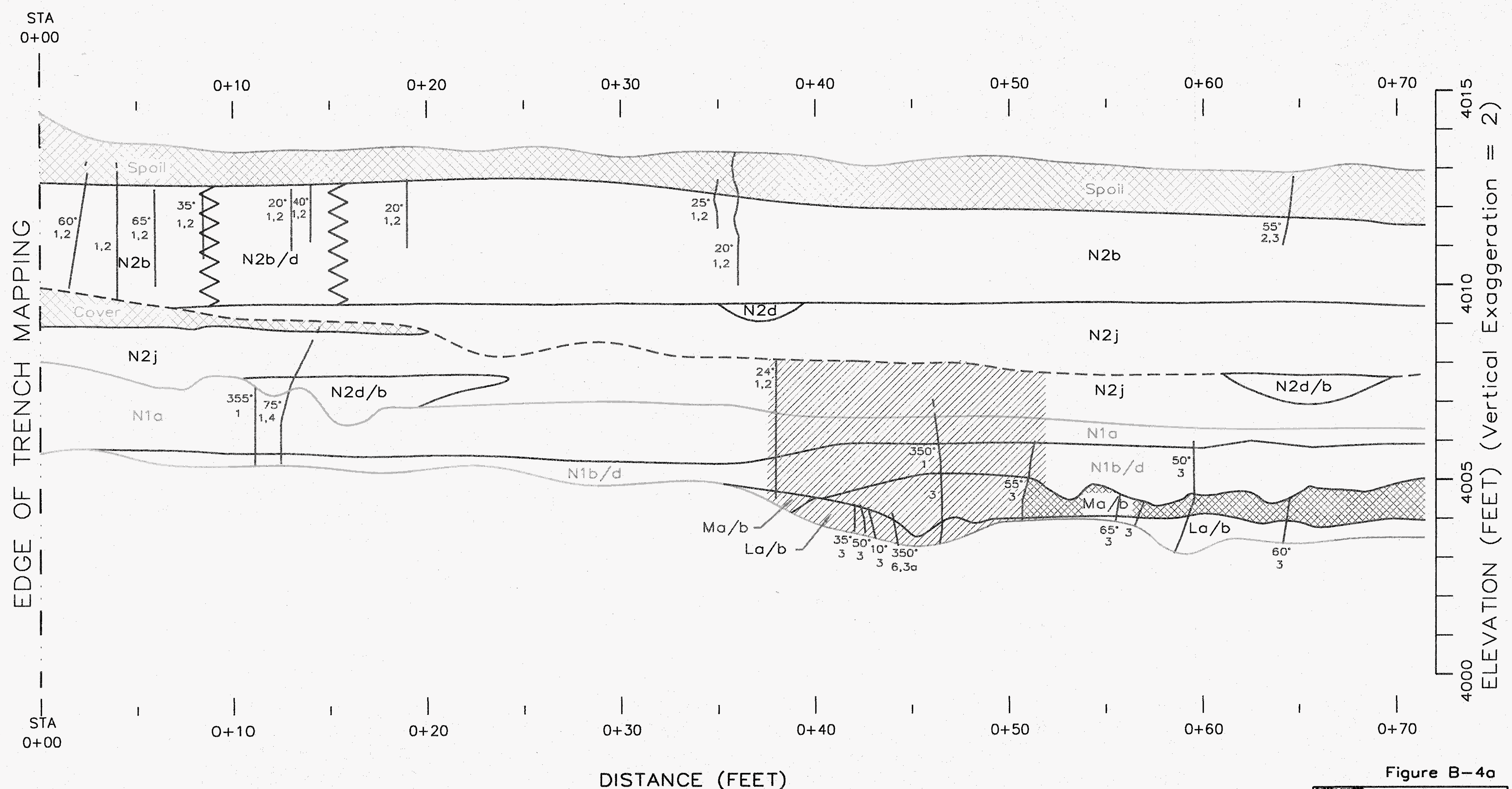

Figure B-4a

STRATIGRAPHY OF NORTH WALL IN SOIL
TRENCH THREE (ST03) SOUTHEASTERN YUCCA FLAT

SHEET 1 of 5

SK-003-97-EM106

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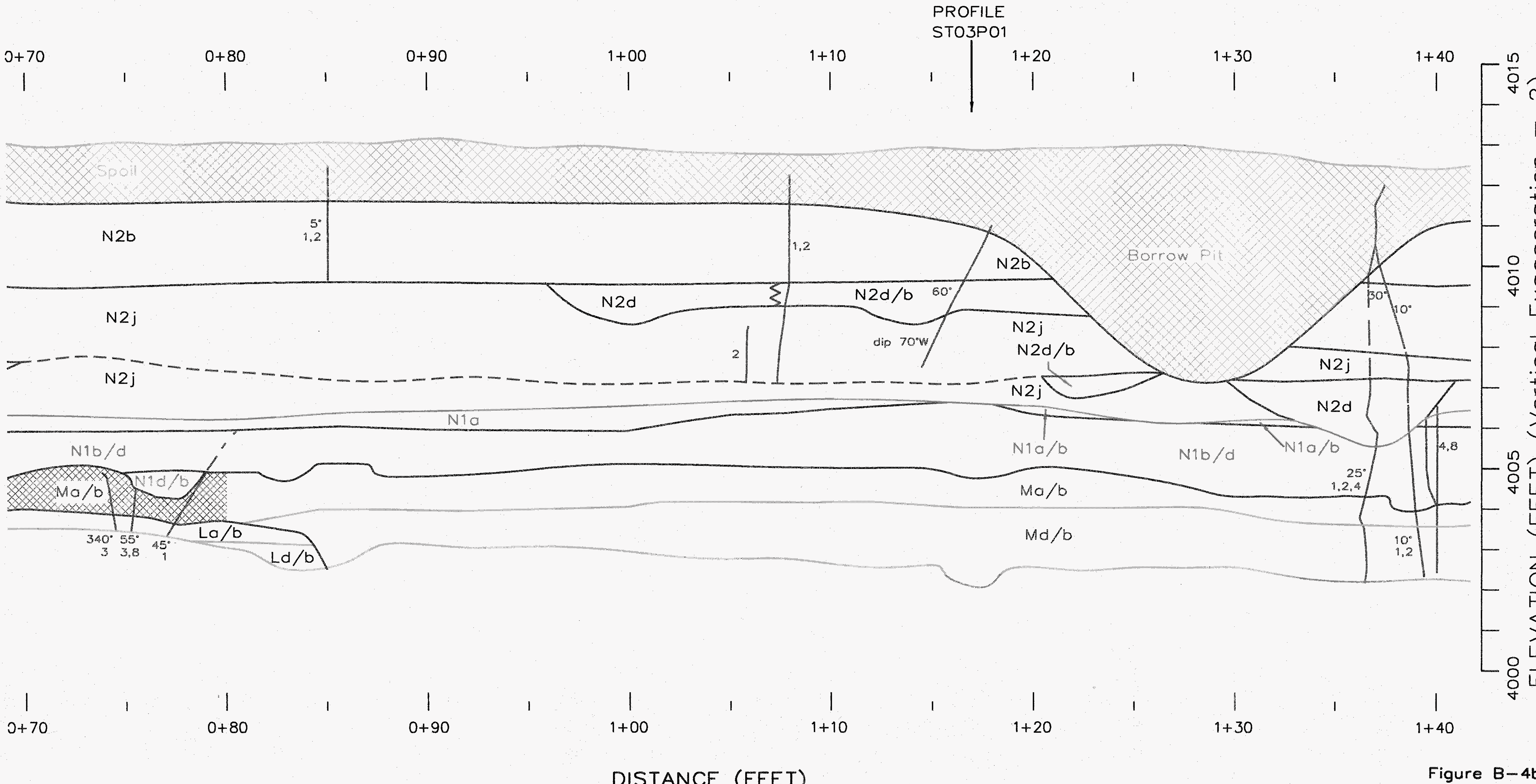

STRATIGRAPHY OF NORTH WALL IN SOIL
TRENCH THREE (ST03) SOUTHEASTERN YUCCA FLAT

Figure B–4b

SKETCH NUMBER
SK-003-97-EM106
PREPARED BY
National Security Technologies LLC

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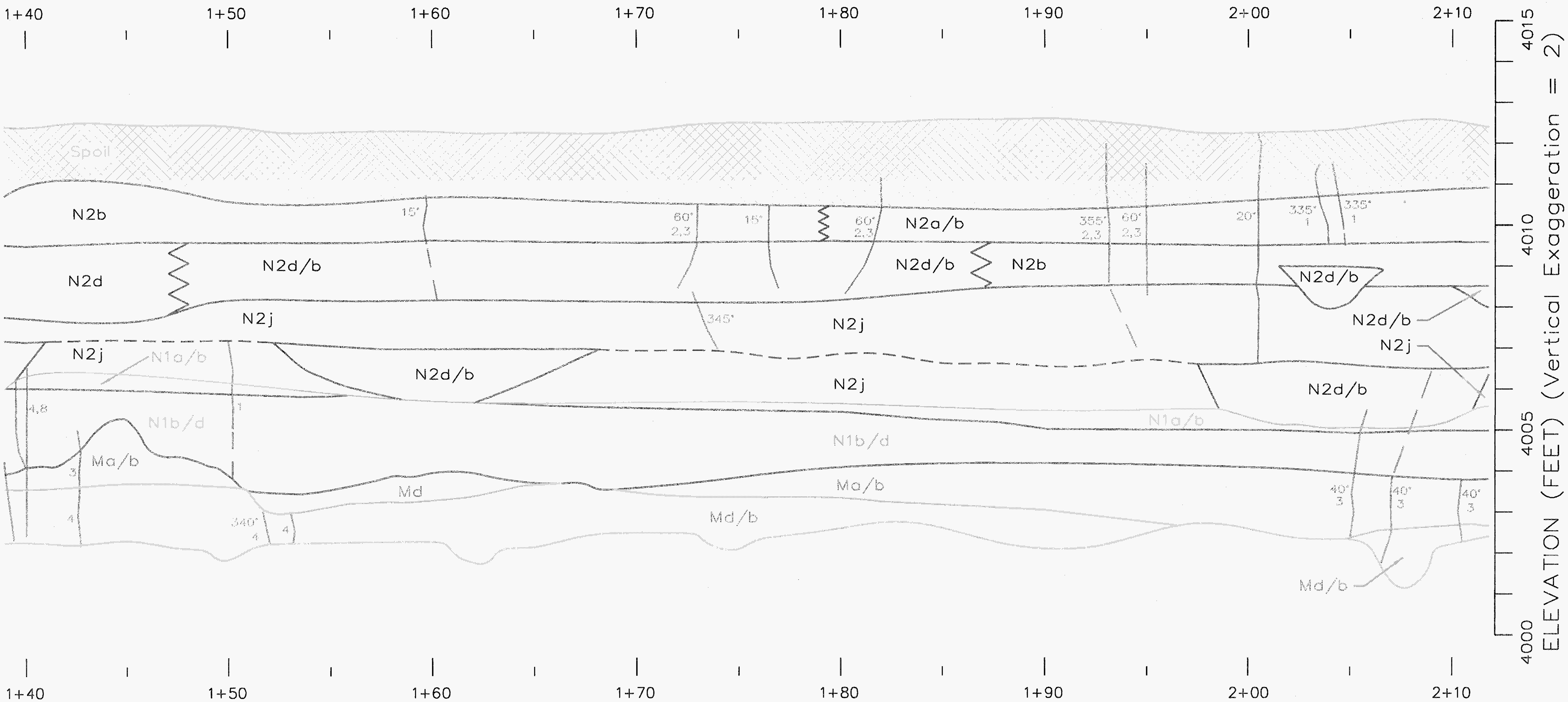
SHEET 2 of 5



STRATIGRAPHY OF NORTH WALL IN SOIL TRENCH THREE (ST03) SOUTHEASTERN YUCCA FLAT

SHEET 3 of 5

Figure B-4c

SKETCH NUMBER
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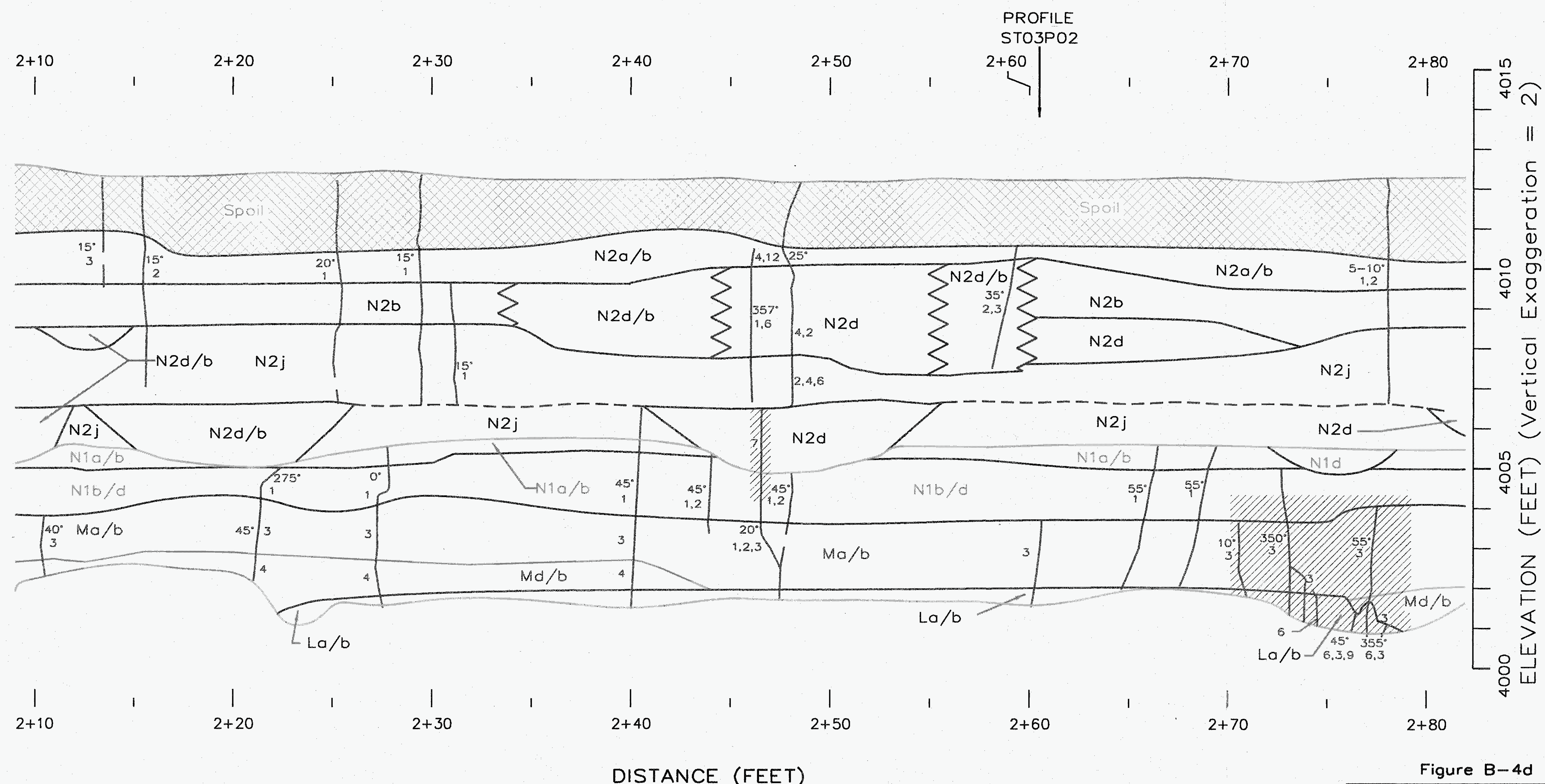

STRATIGRAPHY OF NORTH WALL IN SOIL
TRENCH THREE (ST03) SOUTHEASTERN YUCCA FLAT

Figure B–4d

SKETCH NUMBER
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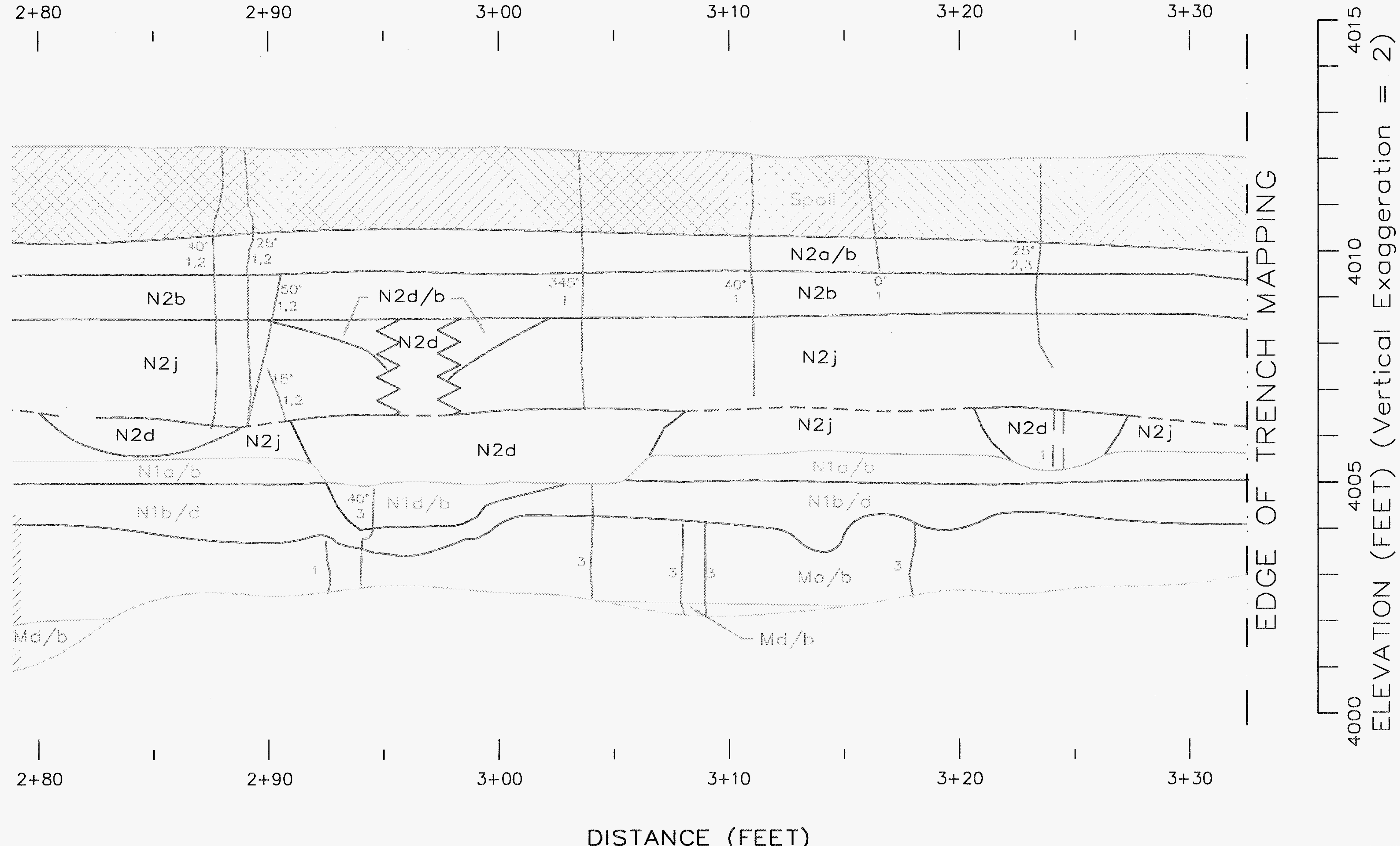

STRATIGRAPHY OF NORTH WALL IN SOIL
TRENCH THREE (ST03) SOUTHEASTERN YUCCA FLAT

Figure B-4e

SKETCH NUMBER
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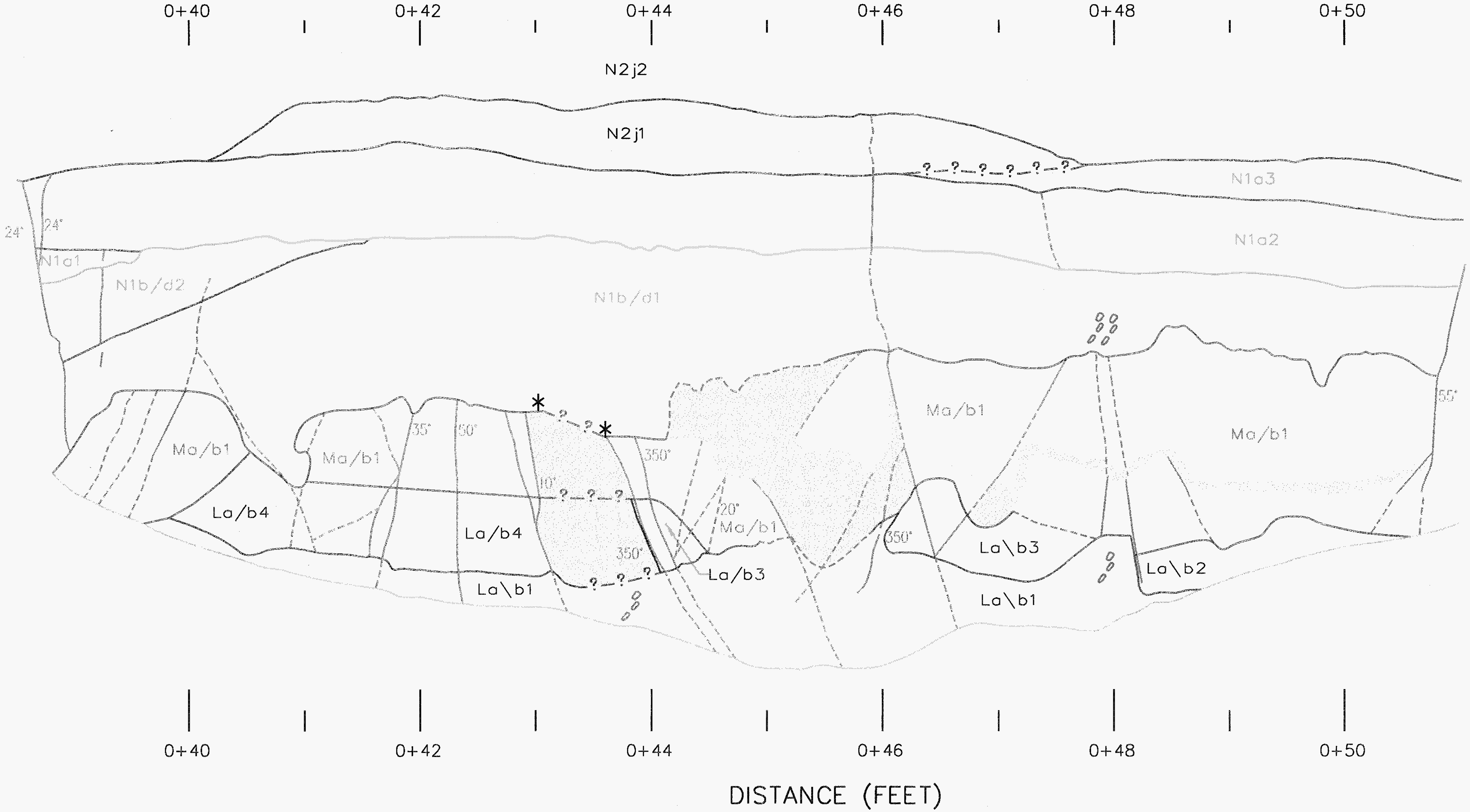

SCALE: 1 inch = 1 foot

0 1 2 (feet)

SHEET 1 of 1

DETAIL MAP OF FRACTURE ZONE BETWEEN STATIONS 0+40 AND 0+50, LOWER LEVEL OF TRENCH ST03 (Refer To Figure B-4a)

Figure B-5

SKETCH NUMBER
SK-003-97-EM110
PREPARED BY
National Security Technologies LLC

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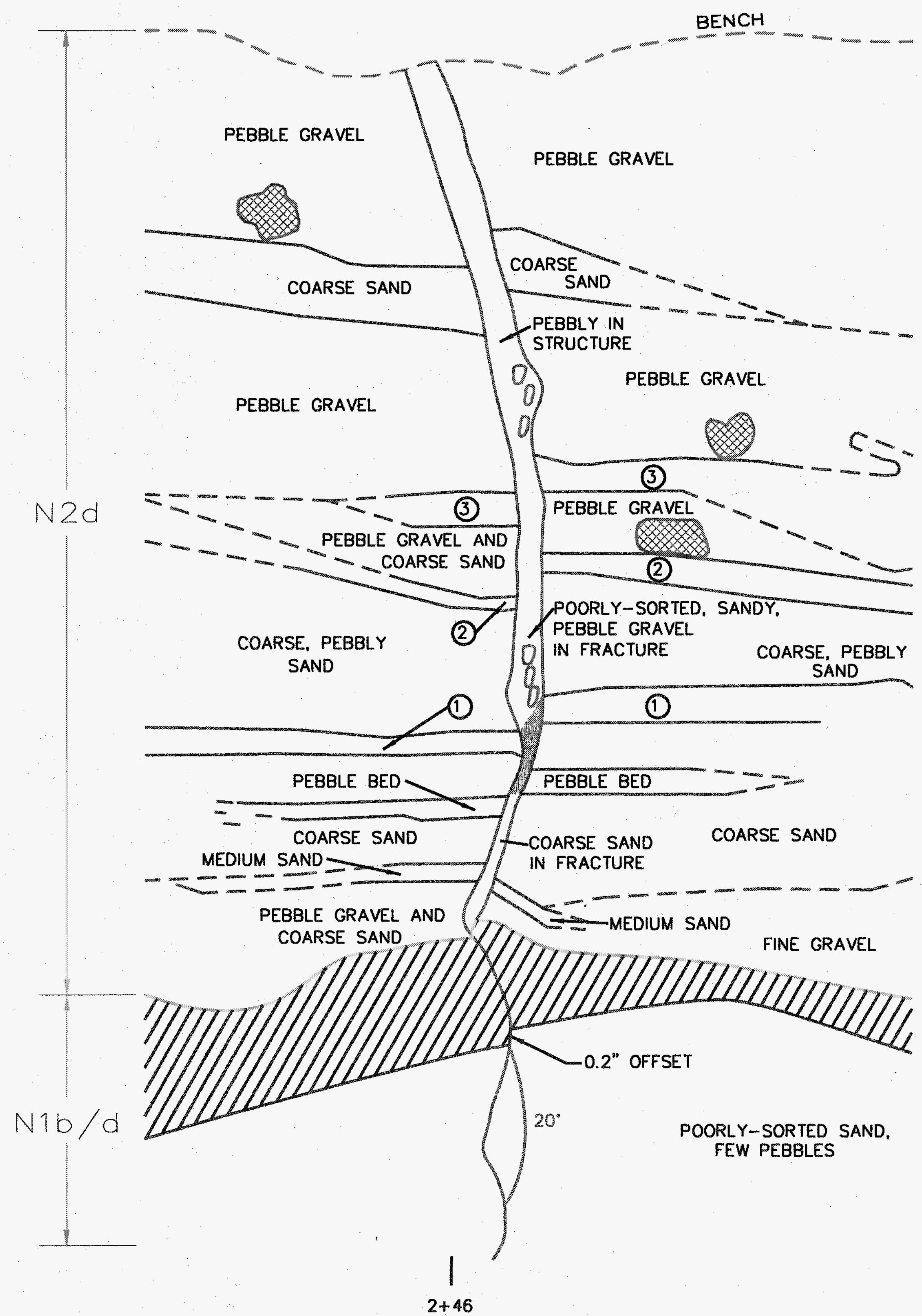


1. SILTY BED, 0.4 – 0.6 INCHES THICK. HORIZONTAL WHITE RHIZOLITHS AT OR NEAR BASE. ABRUPT TOP. ABRUPT BASE OVERLIES 0.6 INCHES LAYER OF MEDIUM, MODERATELY-SORTED SAND, OFFSET MEASURED AT 0.6 INCHES, DOWN TO WEST.
2. SLIGHTLY MORE RESISTANT, MODERATELY WELL-SORTED MEDIUM SAND BED, 0.4 INCHES THICK. OFFSET MEASURED AT 0.6 INCHES DOWN TO WEST. FRACTURE ZONE IS 0.5 INCHES WIDE.
3. OFFSET MEASURED AT 0.5 INCHES DOWN TO WEST. FRACTURE ZONE IS 0.4 INCHES WIDE. BED IS 0.4 INCHES THICK.

DETAIL OF FRACTURE OFFSETTING BEDS NEAR STATION 2+46 OF TRENCH ST03

Figure B-6

SCALE: 1 inch = 0.2 feet

0 0.2 0.4 (feet)

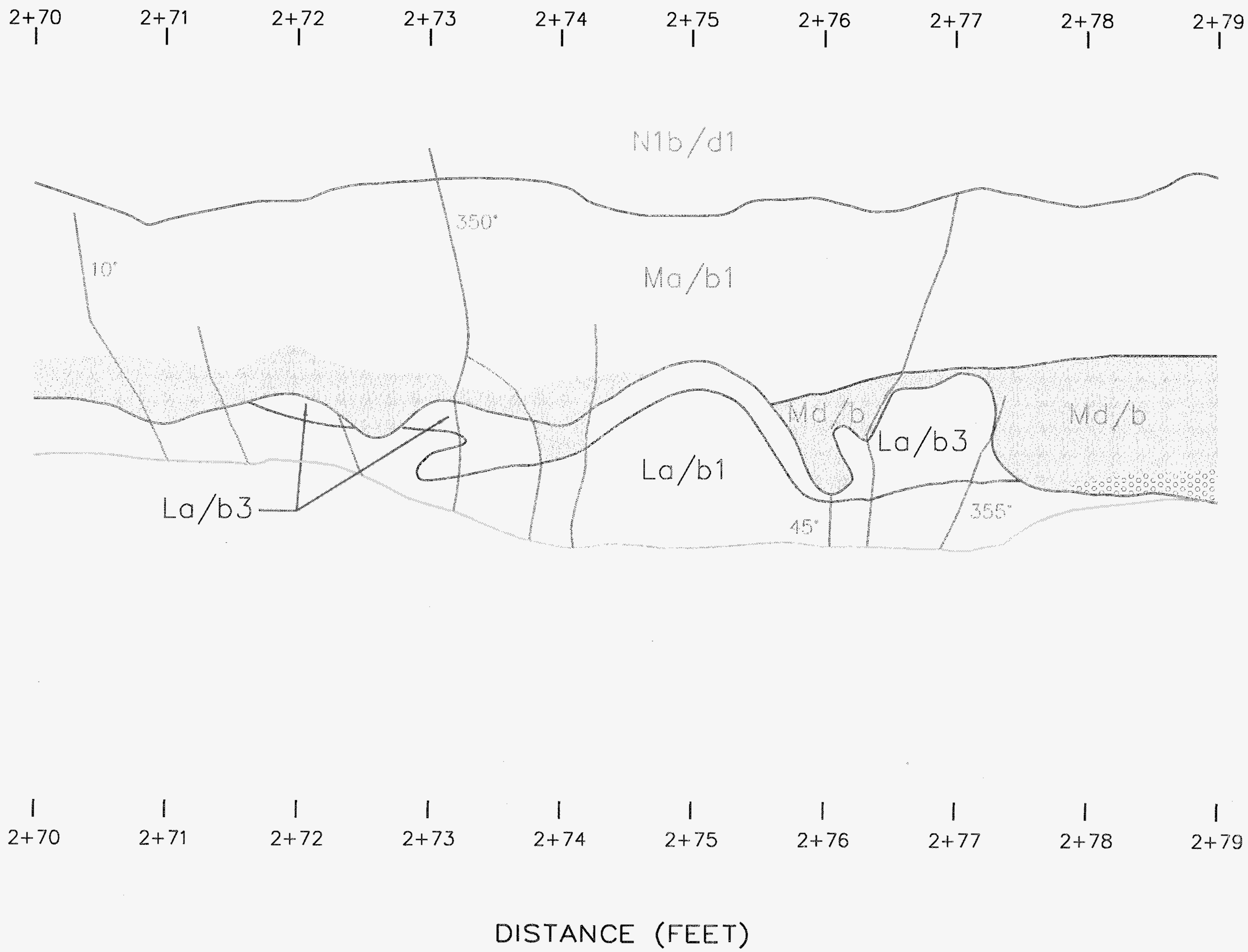
SKETCH NUMBER
SK-003-97-EM108

PREPARED BY

National Security Technologies LLC

G:/Atlas RWMS/Area 3/Reports/sk97em108.dgn

SHEET 1 of 1



SCALE: 1 inch = 1 foot

0 1 2 (feet)

SHEET 1 of 1

DETAIL MAP OF FRACTURE ZONE BETWEEN STATIONS 2+70 AND 2+79, LOWER LEVEL OF TRENCH ST03 (Refer To Figures B-4d and B-4e)

Figure B-7

SKETCH NUMBER SK-003-97-EM107

PREPARED BY

National Security Technologies LLC

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APPENDIX C

SOIL PROFILE DESCRIPTIONS

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Appendix C includes descriptions of 24 soil excavations and trenches that were dug in order to understand the subsurface geology at or near the Area 3 RWMS. Descriptions included are as follows:

- Nine soil excavations are described (EX01-P01 through EX09-P01) that were hand-dug throughout the general area, and which represent geomorphic surfaces.
- Soil Trench 1 (ST01) includes six soil profiles (ST01-P01 through ST01-P06) that describe the soils only. This trench was not dug for fault evidence and was not mapped.
- Soil Trench 2 (ST02) includes seven profiles (ST02-P01 through ST02-P07). This trench was dug not only to describe soils, but to seek evidence for the existence of the Area 3 fault.
- Soil Trench 3 (ST03) includes two profiles (ST03-P01 through ST03-P03). This trench was dug not only to describe soils, but to seek evidence for the existence of the Area 3 fault.

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SOIL EXCAVATIONS EX01-P01 THROUGH EX09-P01

SOIL PROFILE EX01-P01

Location: Excavation at ground level, approximately 1.2 mile (1.9 km) northeast of NTS Area 3 RWMS; Nevada State Plane coordinates 843670 feet north and 688733 feet east; 4115 feet (1254 meters) elevation.

Described by: R. D. Van Remortel and K. E. Snyder

Sampled by: R. D. Van Remortel

Date described / sampled: 2 May 1996 / 21 May 1996

Geomorphic surface: S5a or S4 *

Taxonomic classification of uppermost deposit: Haplargid (in Unit *)

Taxonomic classification of pedon: Coarse-loamy, mixed, thermic Typic Haplargids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

A1 0 to 1.2 in. (0 to 3 cm). Light gray (10YR7/2) gravelly loamy sand, dark yellowish-brown (10YR4/4) moist; moderate thin platy structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; few fine roots; common coarse vesicular pores; few thin paleocarbonate coatings on sides of rock fragments; 5 percent cobbles and 15 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and sample a01a)

A2 1.2 to 2.8 in. (3 to 7 cm). Light yellowish-brown (10YR6/4) sandy loam, dark yellowish-brown (10YR4/6) moist; moderate thin platy structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common coarse vesicular pores; few thin paleocarbonate coatings on sides of rock fragments; 2 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and sample a01b)

BA 2.8 to 8.3 in. (7 to 21 cm). Pink (7.5YR7/3) sandy loam, brown (7.5YR5/4) moist; moderate coarse prismatic structure, parting to moderate thick platy; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few fine and medium vesicular pores; very few thin argillans lining pores and on contacts between fine pebbles and ped surfaces; Stage I- carbonate development; very few very fine carbonate masses and very few thin carbonate coatings lining pores and old root channels; 2 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and sample a02)

2Bk 8.3 to 13.4 in. (21 to 34 cm). Pink (7.5YR7/3) sandy loam, brown (7.5YR5/4) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; few fine vesicular pores; very few thin argillans lining pores and old root channels; Stage I carbonate development; few thin carbonate coatings lining pores, old root channels, and undersides of rock fragments; 5 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and sample a03)

2Btkb 13.4 to 16.5 in. (34 to 42 cm). Pink (7.5YR7/3) sandy loam, reddish-yellow (7.5YR6/6) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few very fine roots; few fine vesicular pores; few thin argillans lining pores and on contacts between fine pebbles and ped surfaces; Stage I+ carbonate development; common thin carbonate coatings lining pores, old root channels, and undersides of rock fragments; 10 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and sample a04)

2Bkb 16.5 to 23.6 in. (42 to 60 cm). Pink (7.5YR7/3) sandy loam, brown (7.5YR4/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; Stage I carbonate development; few very thin carbonate coatings lining pores, old root channels, and undersides of rock fragments; 12 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks. (Unit * and sample a05)

NOTES: Location was determined from a 1:48,000 base map and is accurate to within 50 ft (15 m). Elevation was determined from a 1:48,000 base map and is accurate to within 5 ft (1.5 m). Diagnostic features include an ochric epipedon 0 to 2.7 in. (0 to 7 cm) and argillic horizon 13.4 to 16.5 in. (34 to 42 cm). The thickness of the eolian mantle in this pedon is 8.2 in. (*21 cm), including 2.7 in. (7 cm) of local sandy eolian material capping the soil surface. The argillic horizon contains 3 percent or more clay than the original C horizon parent material is presumed to have contained.

SOIL PROFILE EX02-P01

Location: Excavation at ground level, approximately 1.2 mile (1.9 km) northeast of NTS Area 3 RWMS; Nevada State Plane coordinates 843918 feet north and 688461 feet east; 4115 feet (1254 meters) elevation.

Described by: R. D. Van Remortel and K. E. Snyder

Sampled by: R. D. Van Remortel

Date described / sampled: 2 May 1996 / 21 May 1996

Geomorphic surface: S5a

Taxonomic classification of uppermost deposit: Haplocambid (in Unit *)

Taxonomic classification of pedon: Sandy-skeletal, mixed, thermic Typic Haplocambids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

A 0 to 3.5 in. (0 to 9 cm). Pale brown (10YR6/3) gravelly loamy sand, dark brown (10YR4/3) moist; weak thin platy structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; common fine roots; few thin paleocarbonate coatings on sides of rock fragments; 30 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and sample a01)

BA 3.5 to 9.8 in. (9 to 25 cm). Very pale brown (10YR7/3) gravelly sand, dark yellowish-brown (10YR4/4) moist; weak medium prismatic structure parting to weak thin platy and weak coarse subangular blocky; soft, very friable, nonsticky and nonplastic; few fine roots; few thin paleocarbonate coatings on sides of rock fragments; 25 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and sample a02)

Bk 9.8 to 18.5 in. (25 to 47 cm). Pink (7.5YR7/3) very gravelly sand, dark brown (7.5YR4/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine roots; Stage I carbonate development; few fine carbonate masses and common thin carbonate coatings on undersides of rock fragments; 45 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and sample a03)

BCk 18.5 to 23.6 in. (47 to 60 cm). Pinkish-gray (7.5YR7/2) very gravelly coarse sand, light brown (7.5YR6/3) moist; weak fine subangular blocky structure with areas of very faint relict bedding; soft, very friable, nonsticky and nonplastic; few fine roots; Stage I carbonate development; few thin carbonate coatings on undersides of rock fragments; 45 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks. (Unit * and sample a04)

NOTES: Location was determined from a 1:48,000 base map and is accurate to within 50 ft. (15 m). Elevation was determined from a 1:48,000 base map and is accurate to within 5 ft (1.5 m). Diagnostic features include an ochric epipedon 0 to 3.5 in. (0 to 9 cm) and cambic horizon 9.8 to 18.5 in. (25 to 47 cm).

SOIL PROFILE EX03-P01

Location: Excavation along stream cut just east of powerline road, approximately 3 miles (4.8 km) east of NTS Area 3 RWMS; Nevada State Plane coordinates 838709 feet north and 700341 feet east; 4265 feet (1300 meters) elevation.

Described by: R. D. Van Remortel and K. E. Snyder

Sampled by: R. D. Van Remortel

Date described / sampled: 2 May 1996 / 20 May 1996

Geomorphic surface: S4

Taxonomic classification of uppermost deposit: Haplargid (in Unit *)

Taxonomic classification of pedon: Loamy-skeletal, mixed, thermic Typic Haplargids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

A 0 to 0.8 in. (0 to 2 cm). Pale brown (10YR6/3) extremely gravelly very fine sandy loam, dark brown (10YR4/3) moist; weak thin platy structure parting to weak fine granular; soft, very friable, slightly sticky and slightly plastic; many fine vesicular pores; common thin paleocarbonate coatings on sides of rock fragments; common black cryptogams on soil surface; 5 percent cobbles and 75 percent pebbles from mixed calcareous sedimentary and pyroclastic rocks; abrupt wavy boundary. (Unit * and sample a01a)

BAq 0.8 to 6.7 in. (2 to 17 cm). Very pale brown (10YR7/3) gravelly loam, yellowish-brown (10YR5/6) moist; moderate coarse prismatic structure parting to strong medium platy; hard, firm, sticky and plastic; few fine roots; many medium and coarse vesicular pores; very few thin argillans lining old root channels; common thin silica coatings on undersides of rock fragments and structural plates; common thin paleocarbonate coatings on sides of rock fragments; 20 percent pebbles from mixed calcareous sedimentary and pyroclastic rocks; abrupt wavy boundary. (Unit * and sample a01b)

2Btk 6.7 to 12.6 in. (17 to 32 cm). Pink (7.5YR7/3) extremely gravelly sandy loam, strong brown (7.5YR5/6) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine and medium roots; few thin argillans on contacts between fine pebbles and ped surfaces; Stage I+ carbonate development; common thin carbonate coatings lining old root channels and common pinkish-white (7.5YR8/2) 5-mm carbonate pendants on undersides of rock fragments; 10 percent cobbles and 50 percent pebbles from mixed calcareous sedimentary and pyroclastic rocks; clear wavy boundary. (Unit * and sample a02)

2Bk1 12.6 to 23.6 in. (32 to 60 cm). Pink (7.5YR7/3) very gravelly loamy sand, brown (7.5YR5/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots; Stage I+ carbonate development; common thin carbonate coatings and common pinkish-white (7.5YR8/2) 3-mm pendants on undersides of rock fragments; 5 percent cobbles and 50 percent pebbles from mixed calcareous sedimentary and pyroclastic rocks; clear wavy boundary. (Unit * and sample a03)

2Bk2 23.6 to 34.2 in. (60 to 87 cm). Pink (7.5YR7/3) extremely gravelly sandy loam, strong brown (7.5YR5/6) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots; Stage I+ carbonate development; common thin carbonate coatings and common pink (7.5YR8/3) 5- to 8-mm pendants on undersides of rock fragments; 5 percent cobbles and 55 percent pebbles from mixed calcareous sedimentary and pyroclastic rocks; abrupt wavy boundary. (Unit * and sample a04)

3Btkmb 34.2 37.4 in. (87 to 95 cm). Red (2.5YR5/6) and pinkish-white (5YR8/2) extremely gravelly loamy sand, red (2.5YR4/6) and pink (5YR7/3) moist; strong medium subangular blocky structure; extremely hard, slightly rigid, nonsticky and nonplastic; common thin argillans on contacts between fine pebbles and ped surfaces; Stage III+ carbonate development; pink (7.5YR7/3, 6/3 moist) 2-mm carbonate lamina capping top of horizon; 90 percent strongly carbonate-cemented with many pinkish-white (7.5YR8/2) moderately thick carbonate pendants on undersides of rock fragments; 10 percent cobbles and 60 percent pebbles from mixed calcareous sedimentary and pyroclastic rocks. (Unit * and no sample collected)

NOTES: Location was determined from a 1:48,000 base map and is accurate to within 50 ft. (15 m). Elevation was determined from a 1:48,000 base map and is accurate to within 5 ft (1.5 m). Diagnostic features include an ochric epipedon 0 to .8 in. (0 to 2 cm) and argillic horizon 6.7 to 12.6 in. (17 to 32 cm). The thickness of the eolian mantle in this pedon is 6.7 in. (17 cm). The argillic horizon contains 3 percent or more clay than the original C horizon parent material is presumed to have contained.

SOIL PROFILE EX04-P01

Location: Excavation at ground level, approximately 4 miles (6.4 km) northeast of NTS Area 3 RWMS; Nevada State Plane coordinates 842723 feet north and 697640 feet east; 4250 feet (1295 meters) elevation.

Described by: R. D. Van Remortel and K. E. Snyder

Date described: 6 May 1996

Geomorphic surface: S5a

Taxonomic classification of uppermost deposit: Haplocambid (in Unit *)

Taxonomic classification of pedon: Sandy-skeletal, mixed, thermic Typic Haplocambi

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

A 0 to 5.9 in. (0 to 15 cm). Pale brown (10YR6/3) very gravelly sandy loam, dark yellowish- brown (10YR4/4) moist; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; few fine roots; few medium interstitial pores; few thin paleocarbonate coatings on sides of rock fragments; 2 percent cobbles and 50 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)

Bqk 5.9 to 12.6 in. (15 to 32 cm). Pink (7.5YR7/3) very gravelly loamy sand, dark brown (7.5YR4/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots; few medium interstitial pores; common thin silica coatings on undersides of rock fragments; Stage I- carbonate development; few thin carbonate coatings on undersides of rock fragments; common thin paleocarbonate coatings on sides of rock fragments; 55 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)

Bck 12.6 to 24.0 in. (32 to 61 cm). Very pale brown (10YR7/3) extremely gravelly sand, yellowish- brown (10YR5/4) moist; weak medium subangular blocky structure with areas of very faint relict bedding; soft, very friable, nonsticky and nonplastic; few fine and medium roots; Stage I- carbonate development; few thin carbonate coatings on undersides of rock fragments; common thin paleocarbonate coatings on sides of rock fragments; 60 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)

C 24.0 to 30.7 in. (61 to 78 cm). Very pale brown (10YR7/3) very gravelly sand, yellowish-brown (10YR5/4) moist; single grain with faint relict bedding; soft, very friable, nonsticky and nonplastic; few very fine roots; few thin paleocarbonate coatings on sides of rock fragments; 55 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and no sample collected)

2Bkb 30.7 to39.4 in. (78 to 100 cm). Pinkish-gray (7.5YR6/2) very gravelly sand, brown (7.5YR5/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine roots; Stage I- carbonate development; few thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 2 percent cobbles and 45 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks. (Unit * and no sample collected)

NOTES: Location was determined from a 1:48,000 base map and is accurate to within 50 ft (15 m). Elevation was determined from a 1:48,000 base map and is accurate to within 5 ft (1.5 m). Diagnostic features include an ochric epipedon 0 to 5.9 in. (0 to 15 cm) and cambic horizon 5.9 to 12.6 in. (15 to 32 cm).

SOIL PROFILE EX05-P01

Location: Excavation at ground level, approximately 4 miles (6.4 km) northeast of NTS Area 3 RWMS; Nevada State Plane coordinates 842796 feet north and 697574 feet east; 4250 feet (1295 meters) elevation.

Described by: R. D. Van Remortel and K. E. Snyder

Sampled by: R. D. Van Remortel

Date described / sampled: 6 May 1996 / 21 May 1996

Geomorphic surface: S7

Taxonomic classification of uppermost deposit: Riverwash over Haplocambid (in Unit *)

Taxonomic classification of pedon: Sandy-skeletal, mixed, thermic Typic Haplocambids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

C1 0 to 4.3 in. (0 to 11 cm). Pale brown (10YR6/3) very gravelly sand, yellowish-brown (10YR5/4) moist; single grain with faint recent bedding; loose, nonsticky and nonplastic; few very fine roots; common thin paleocarbonate coatings on sides of rock fragments; 40 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and sample a01a)

C2 4.3 to 9.4 in. (11 to 24 cm). Pale brown (10YR6/3) very gravelly sand, yellowish-brown (10YR5/4) moist; single grain with distinct relict bedding; soft, very friable, nonsticky and nonplastic; few very fine roots; very few thin silica coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 45 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and sample a01b)

2BCqkb 9.4 to 21.6 in. (24 to 55 cm). Pink (7.5YR7/3) extremely gravelly sand, brown (7.5YR5/4) moist; weak fine subangular blocky structure with faint relict bedding in lower part; slightly hard, friable, nonsticky and nonplastic; few very fine roots; common thin silica coatings on undersides of rock fragments; Stage I+ carbonate development; few thin carbonate coatings and few pendants on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 1 percent cobbles and 60 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks. (Unit * and sample a02)

NOTES: Location was determined from a 1:48,000 base map and is accurate to within 50 ft (15 m). Elevation was determined from a 1:48,000 base map and is accurate to within 5 ft (1.5 m). Diagnostic features include riverwash 0 to 9.4 in. (0 to 24 cm).

SOIL PROFILE EX06-P01

Location: Excavation at ground level approximately 4 miles (6.4 km) northeast of NTS Area 3 RWMS; Nevada State Plane coordinates 842884 feet north and 697496 feet east; 4250 feet (1295 meters) elevation.

Described by: R. D. Van Remortel and K. E. Snyder

Sampled by: R. D. Van Remortel

Date described / sampled: 6 May 1996 / 21 May 1996

Geomorphic surface: S6

Taxonomic classification of uppermost deposit: Haplocambid (in Unit *)

Taxonomic classification of pedon: Sandy-skeletal, mixed, thermic Typic Haplocambids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

AC 0 to 2.8 in. (0 to 7 cm). Pale brown (10YR6/3) very gravelly sand, yellowish-brown (10YR5/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; few very fine roots; common thin paleocarbonate coatings on sides of rock fragments; 1 percent stones, 2 percent cobbles, and 50 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and sample a01)

Bw 2.8 to 6.3 in. (7 to 16 cm). Very pale brown (10YR7/3) very gravelly sand, dark yellowish- brown (10YR4/4) moist; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine roots; few thin paleocarbonate coatings on sides of rock fragments; 2 percent cobbles and 45 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and sample a02)

BCk 6.3 to 15.7 in. (16 to 40 cm). Very pale brown (10YR7/3) very gravelly sand, yellowish-brown (10YR5/4) moist; single grain with pockets of faint relict bedding; soft, very friable, nonsticky and nonplastic; few fine roots; very few thin silica coatings on undersides of rock fragments; few thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 2 percent cobbles and 50 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and sample a03)

NOTES: Location was determined from a 1:48,000 base map and is accurate to within 50 ft (15 m). Elevation was determined from a 1:48,000 base map and is accurate to within 5 ft (1.5 m). Diagnostic features include an ochric epipedon 0 to 2.7 in. (0 to 7 cm) and cambic horizon 2.7 to 6.3 in. (7 to 16 cm).

SOIL PROFILE EX07-P01

Location: Excavation at ground level, approximately 4 miles (6.4 km) northeast of NTS Area 3 RWMS; Nevada State Plane coordinates 842944 feet north and 697443 feet east; 4250 feet (1295 meters) elevation.

Described by: R. D. Van Remortel and K. E. Snyder

Sampled by: R. D. Van Remortel

Date described / sampled: 6 May 1996 / 21 May 1996

Geomorphic surface: S5b

Taxonomic classification of uppermost deposit: Haplocambid (in Unit *)

Taxonomic classification of pedon: Sandy-skeletal, mixed, thermic Typic Haplocambids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

A 0 to 3.5 in. (0 to 9 cm). Pale brown (10YR6/3) very gravelly loamy sand, dark yellowish- brown (10YR4/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; few fine roots; common thin paleocarbonate coatings on sides of rock fragments; 5 percent stones, 5 percent cobbles, and 40 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and sample a01)

Bw 3.5 to 14.6 in. (9 to 37 cm). Pink (7.5YR7/3) extremely gravelly loamy sand, light brown (7.5YR6/4) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common fine and medium roots; very few thin silica coatings on undersides of rock fragments; very few thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 15 percent stones, 10 percent cobbles, and 40 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and sample a02)

Bk1 14.6 to 24.8 in. (37 to 63 cm). Pink (7.5YR7/3) very gravelly loamy sand, light brown (7.5YR6/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; Stage I carbonate development; common thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 5 percent stones, 5 percent cobbles, and 40 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; gradual wavy boundary. (Unit * and sample a03)

Bk2 24.8 to 33.8 in. (63 to 86 cm). Pinkish-gray (7.5YR7/2) very gravelly sand, light brown (7.5YR6/3) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine roots; Stage I carbonate development; common thin carbonate coatings on undersides of rock fragments; common thin paleocarbonate coatings on sides of rock fragments; 10 percent cobbles and 40 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and sample a04)

BCk 33.8 to 39.4 in. (86 to 100 cm). Very pale brown (10YR7/3) extremely gravelly sand, brown (10YR4/3) moist; single grain with very faint relict bedding; loose, nonsticky and nonplastic; few very fine roots; Stage I+ carbonate development; common carbonate pendants on undersides of rock fragments; common thin paleocarbonate coatings on sides of rock fragments; 5 percent cobbles and 60 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; (Unit * and sample a05)

NOTES: Location was determined from a 1:48,000 base map and is accurate to within 50 ft (15 m). Elevation was determined from a 1:48,000 base map and is accurate to within 5 ft (1.5 m). Diagnostic features include an ochric epipedon 0 to 3.5 in. (0 to 9 cm) and cambic horizon 3.5 to 33.8 in. (9 to 86 cm).

SOIL PROFILE EX08-P01

Location: Excavation at ground level, approximately 1.2 mile (1.9 km) northeast of NTS Area 3 RWMS; Nevada State Plane coordinates 839515 feet north and 693632 feet east; 4125 feet (1257 meters) elevation.

Described by: R. D. Van Remortel

Sampled by: R. D. Van Remortel

Date described / sampled: 30 May 1996 / 6 Jun 1996

Geomorphic surface: S5a

Taxonomic classification of uppermost deposit: Haplocambid (in Unit *)

Taxonomic classification of pedon: Sandy-skeletal, mixed, thermic Typic Haplocambids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

A 0 to 3.1 in. (0 to 8 cm). Brown (10YR5/3) very gravelly loamy sand, dark yellowish-brown (10YR3/4) moist; weak coarse subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; few very fine roots; few fine interstitial pores; few thin paleocarbonate coatings on sides of rock fragments; 5 percent cobbles and 40 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and sample a01)

Bqk 3.1 to 9.8 in. (8 to 25 cm). Pink (7.5YR7/3) gravelly loamy sand, dark brown (7.5YR4/4) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few fine roots; few thin silica coatings on undersides of rock fragments; Stage I- carbonate development; few thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 30 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and sample a02)

Bk1 9.8 to 17.0 in. (25 to 43 cm). Pink (7.5YR7/3) very gravelly sandy loam, dark brown (7.5YR4/4) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; few fine roots; Stage I+ carbonate development; common thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 40 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and sample a03)

Bk2 17.0 to 25.2 in. (43 to 64 cm). Pink (7.5YR7/3) very gravelly loamy sand, strong brown (7.5YR5/6) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; Stage I carbonate development; common thin carbonate coatings on undersides of rock fragments; common thin paleocarbonate coatings on sides of rock fragments; 2 percent cobbles and 40 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; gradual wavy boundary. (Unit * and sample a04)

BCqk 25.2 to 35.4 in. (64 to 90 cm). Light gray (10YR7/2) extremely gravelly sand, yellowish-brown (10YR5/4) moist; single grain with areas of faint relict bedding; slightly hard, friable, nonsticky and nonplastic; few very fine roots; common thin silica coatings on undersides of rock fragments; Stage I- carbonate development; common thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 10 percent cobbles and 55 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks. (Unit * and sample a05)

NOTES: Location was determined from a 1:48,000 base map and is accurate to within 50 ft (15 m). Elevation was determined from a 1:48,000 base map and is accurate to within 5 ft (1.5 m). Diagnostic features include an ochric epipedon 0 to 3.15 in. (0 to 8 cm) and cambic horizon 3.15 to 25.2 in. (8 to 64 cm).

SOIL PROFILE EX09-P01

Location: Excavation at ground level, approximately 0.6 mile (1 km) north of NTS Area 3 RWMS; Nevada State Plane coordinates and elevation were not determined.

Described by: R. D. Van Remortel

Date described: 10 September 1996

Geomorphic surface: S5a

Taxonomic classification of uppermost deposit: Haplocambid (in Unit *)

Taxonomic classification of pedon: Sandy, mixed, thermic Typic Haplocambids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

A 0 to 2.0 in. (0 to 5 cm). Pale brown (10YR6/3) gravelly loamy sand, dark brown (10YR3/3) moist; weak medium granular structure; soft, very friable, nonsticky and nonplastic; common fine roots; few thin paleocarbonate coatings on sides of rock fragments; 30 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and no sample collected)

BA 2.0 to 4.3 in. (5 to 11 cm). Light brown (7.5YR6/4) loamy sand, dark brown (7.5YR4/4) moist; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common fine roots; few thin paleocarbonate coatings on sides of rock fragments; 5 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)

Bk1 4.3 to 8.3 in. (11 to 21 cm). Light brown (7.5YR6/4) sandy loam, strong brown (7.5YR4/6) moist; moderate fine subangular blocky structure; hard, firm, nonsticky and nonplastic; few fine roots; Stage I carbonate development; few fine soft carbonate masses and few thin carbonate coatings on undersides of rock fragments; 5 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)

Bk2 8.3 to 18.0 in. (21 to 46 cm). Light brown (7.5YR6/4) loamy sand, dark brown (7.5YR4/4) moist; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few fine roots; Stage I carbonate development; few fine soft carbonate masses and few thin carbonate coatings on undersides of rock fragments; 5 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; gradual wavy boundary. (Unit * and no sample collected)

Bkb 18.0 to 31.5 in. (46 to 80 cm). Pink (7.5YR7/3) very gravelly loamy sand, brown (7.5YR5/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine roots; Stage I carbonate development; few fine soft carbonate masses and few thin carbonate coatings on undersides of rock fragments; 10 percent cobbles and 25 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks. (Unit * and no sample collected)

NOTES: Diagnostic features include an ochric epipedon 0 to 2 in. (0 to 5 cm) and cambic horizon 4.3 to 31.5 in. (11 to 80 cm).

SOIL TRENCH 1 – ST01-P01 THROUGH ST01-P06

SOIL PROFILE ST01-P01

Location: Soil Trench 1, Profile 1, located on the east side of Yucca Flat approximately 2.5 miles (4.0 km) northeast of Soil Trench 3 in the Area 3 RWMS; Nevada State Plane coordinates 843990 feet north and 697815 feet east; 4287 feet (1307 meters) elevation.

Described by: R. D. Van Remortel and K. E. Snyder

Date described: 15 October 1996

Geomorphic surface: S3

Taxonomic classification of uppermost deposit: Petrocalcid (in Unit *)

Taxonomic classification of pedon: Sandy-skeletal, mixed, thermic Argic Petrocalcids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

A1 0 to 0.8 in. (0 to 2 cm). Very pale brown (10YR7/3) extremely gravelly fine sandy loam, brown (10YR5/3) moist; strong coarse prismatic structure parting to moderate medium platy; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; many fine vesicular pores; few thin carbonate paleocoatings on sides of rock fragments; 5 percent channer-sized pan fragments, 10 percent cobbles, and 55 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt smooth boundary. (Unit * and no sample collected)

A2 0.8 to 4.3 in. (2 to 11 cm). Very pale brown (10YR7/3) loam, yellowish-brown (10YR5/4) moist; strong coarse prismatic structure parting to weak thick platy; slightly hard, friable, sticky and slightly plastic; few fine roots; common very fine vesicular pores; common irregular hard dark orangish-brown (7.5YR5/8) silica lamina on undersides of structural plates; few thin carbonate paleocoatings on sides of rock fragments; 2 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and no sample collected)

2Btk 4.3 to 7.5 in. (11 to 19 cm). Pink (7.5YR7/4) very gravelly sandy loam, strong brown (7.5YR4/6) moist; moderate fine subangular blocky structure parting to moderate medium granular; slightly hard, friable, slightly sticky and slightly plastic; common fine and medium roots; common very fine interstitial pores; few thin argillans on contacts between peds and pebbles; very few thin silica cutans on undersides of pan fragments; highly degraded and weathered material exhibiting ancestral Stage III carbonate development; fractures 1 to 5 cm apart; 20 percent moderately carbonate-cemented with troweled lamina on undersides of large pan fragments; common thin carbonate coatings and few thin pendants on undersides of rock fragments; 30 percent pebble-sized pan fragments and 20 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and no sample collected)

2Bkm1 7.5 to 15.7 in. (19 to 40 cm). Pinkish-white (7.5YR8/2) very gravelly sand, light brown (7.5YR6/4) moist; moderate coarse subangular blocky structure; very hard, extremely firm, nonsticky and nonplastic; many thin light brown (7.5YR6/4, 6/6 moist) silica cutans along base of horizon; weakly degraded and weathered material exhibiting ancestral Stage IV carbonate development; fractures 5 to 10 cm apart; light brown (7.5YR6/3, 5/4 moist) 1-mm carbonate lamina capping top of horizon; 90 percent strongly carbonate-cemented with common thin carbonate coatings and many moderately thick pendants on undersides of rock fragments; apparent paleoroot channel of 2-cm diameter and 150-cm length along base of horizon contains light reddish-brown (5YR7/4, 4/6 moist) gravelly sand; 2 percent cobbles and 45 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)

2Bkm2 15.7 to 26.7 in. (40 to 68 cm). Pinkish-white (7.5YR8/2) extremely gravelly coarse sand, light brown (7.5YR6/4) moist; moderate medium subangular blocky structure; extremely hard, slightly rigid, nonsticky and nonplastic; very few thin silica cutans on undersides of pendants; Stage IV carbonate development; fractures 30 to 50 cm apart; pink (7.5YR7/3, 6/3 moist) 2-mm carbonate lamina capping top of horizon; 95 percent strongly carbonate-cemented with many thin carbonate coatings and many thick pendants on undersides of rock fragments; 10 percent cobbles and 60 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)

2Bk 26.7 to 39.8 in. (68 to 101 cm). Pinkish-white (7.5YR8/2) extremely gravelly coarse sand, light brown (7.5YR6/4) moist; moderate medium subangular blocky structure; very hard, extremely firm, nonsticky and nonplastic; very few thin silica cutans on undersides of pendants; Stage III carbonate development; fractures 10 to 20 cm apart; 50 percent strongly carbonate-cemented with many thin carbonate coatings and many thick pendants on undersides of rock fragments; large pockets of less-cemented sand and gravel; 10 percent cobbles and 60 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)

2BCk 39.8 to 52.4 in. (101 to 133 cm). Pale brown (10YR6/3) extremely gravelly coarse sand, yellowish-brown (10YR5/4) moist; single grain with faint relict bedding, weak fine subangular blocky structure in some parts; hard, firm, nonsticky and nonplastic; few fine roots; very few thin silica cutans on undersides of pendants; Stage II carbonate development; 70 percent weakly cemented with common thin carbonate coatings and many moderately thick pendants on undersides of rock fragments; 10 percent cobbles and 60 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and no sample collected)

3Bkb1 52.4 to 63.0 in. (133 to 160 cm). Light brown (7.5YR6/3) very gravelly sand, brown (7.5YR5/4) moist; weak medium subangular blocky structure; very hard, extremely firm, nonsticky and nonplastic; Stage II+ carbonate development; discontinuous light brown (7.5YR6/4, 5/4 moist) 1-mm carbonate lamina capping top of horizon; fractures 10 to 30 cm apart; 65 percent moderately carbonate-cemented with many thin carbonate coatings and common moderately thick pendants on undersides of rock fragments; 5 percent cobbles and 45 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)

3Bkb2 63.0 to 70.9 in. (160 to 180 cm). Light brown (7.5YR6/3) very gravelly sand, brown (7.5YR5/4) moist; weak medium subangular blocky structure; hard, firm, nonsticky and nonplastic; Stage II- carbonate development; 30 percent weakly carbonate-cemented with common thin carbonate coatings and common moderately thick pendants on undersides of rock fragments; 2 percent cobbles and 40 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks. (Unit * and no sample collected)

NOTES: Location was determined by using a Global Positioning System and is accurate to within 30 feet (9 meters). Elevation was determined buy using a field altimeter and is accurate to within 2 feet (0.6 meters). Diagnostic features include an ochric epipedon 0 to 4.3 in. (0 to 11 cm), argillic horizon 4.3 to 7.5 in. (11 to 19 cm), and petrocalcic horizon 7.5 to 26.8 in. (19 to 68 cm). The thickness of the eolian mantle in this pedon is 4.3 in. (11 cm). The argillic horizon contains 3 percent or more clay than the original C horizon parent material is presumed to have contained.

SOIL PROFILE ST01-P02

Location: Soil Trench 1, Profile 2, located on the east side of Yucca Flat, approximately 2.5 miles (4.0 km) northeast of Soil Trench 3 in the Area 3 RWMS; Nevada State Plane coordinates 843980 feet north and 697820 feet east; 4287 feet (1307 meters) elevation.

Described by: R. D. Van Remortel and K. E. Snyder

Date described: 16 October 1996

Geomorphic surface: S3

Taxonomic classification of uppermost deposit: Petrocalcid (in Unit *)

Taxonomic classification of pedon: Sandy-skeletal, mixed, thermic Argic Petrocalcids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

A1 0 to 1.2 in. (0 to 3 cm). Pale brown (10YR6/3) extremely gravelly fine sandy loam, yellowish- brown (10YR5/4) moist; strong coarse prismatic structure parting to moderate medium platy; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; many fine vesicular pores; few thin carbonate paleocoatings on sides of rock fragments; 5 percent channer-sized pan fragments, 5 percent cobbles, and 60 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt smooth boundary. (Unit * and no sample collected)

A2 1.2 to 4.3 in. (3 to 11 cm). Very pale brown (10YR7/3) loam, yellowish-brown (10YR5/4) moist; strong coarse prismatic structure parting to weak thick platy; slightly hard, friable, sticky and slightly plastic; few fine roots; common very fine vesicular pores; common irregular hard dark orangish-brown (7.5YR5/8) silica lamina on undersides of structural plates; few thin carbonate paleocoatings on sides of rock fragments; 2 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and no sample collected)

2Btk1 4.3 to7.9 in. (11 to 20 cm). Light brown (7.5YR6/3) very gravelly sandy loam, brown (7.5YR5/3) moist; moderate fine subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common fine and medium roots; common very fine interstitial pores; few thin argillans on contacts between peds and pebbles; very few thin silica cutans on undersides of pan fragments; highly degraded and weathered material exhibiting ancestral Stage III carbonate development; fractures 1 to 5 cm apart; 20 percent very weakly carbonate-cemented with troweled lamina on undersides of large pan fragments; common thin carbonate coatings and few thin pendants on undersides of rock fragments; 15 percent pebble-sized pan fragments and 20 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and no sample collected)

2Btk2 7.9 to 13.8 in. (20 to 35 cm). Light brown (7.5YR6/3) very gravelly sandy loam, brown (7.5YR5/4) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and medium roots; few very fine interstitial pores; few thin argillans on contacts between peds and pebbles; very few thin silica cutans on undersides of pan fragments; highly degraded and weathered material exhibiting ancestral Stage III carbonate development; fractures 1 to 5 cm apart; discontinuous 1-mm carbonate lamina throughout 20 percent weakly carbonate-cemented with troweled lamina on undersides of large pan fragments; common thin carbonate coatings and few thin pendants on undersides of rock fragments; 30 percent pebble-sized pan fragments, 2 percent cobbles, and 20 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and no sample collected)

2Bkm1 13.8 to 18.5 in. (35 to 47 cm). Pinkish-white (7.5YR8/2) very gravelly sand, light brown (7.5YR6/3) moist; moderate coarse subangular blocky structure; very hard, extremely firm, nonsticky and nonplastic; many thin light brown (7.5YR6/4, 6/6 moist) silica cutans along base of horizon; weakly degraded and weathered material exhibiting ancestral Stage IV carbonate development; fractures 5 to 10 cm apart; light brown (7.5YR6/3, 5/4 moist) 1-mm carbonate lamina capping top of horizon; 90 percent strongly carbonate-cemented with common thin carbonate coatings and many moderately thick pendants on undersides of rock fragments; apparent paleoroot channel of 2-cm diameter and 150-cm length along base of horizon contains light reddish-brown (5YR7/4, 4/6 moist) gravelly sand; 2 percent cobbles and 45 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)

2Bkm2 18.5 to 33.1 in. (47 to 84 cm). Pinkish-white (7.5YR8/2) extremely gravelly coarse sand, light brown (7.5YR6/4) moist; moderate medium subangular blocky structure; extremely hard, slightly rigid, nonsticky and nonplastic; very few thin silica cutans on undersides of pendants; Stage III carbonate development; fractures 30 to 50 cm apart; pink (7.5YR7/3, 6/3 moist) 2-mm carbonate lamina capping top of horizon; 95 percent strongly carbonate-cemented with many thin carbonate coatings and many thick pendants on undersides of rock fragments; 10 percent cobbles and 60 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)

2BCk 33.1 to 47.6 in. (84 to 121 cm). Light brown (7.5YR6/3) extremely gravelly coarse sand, brown (7.5YR5/4) moist; single grain with faint relict bedding, weak medium subangular blocky structure in some parts; hard, firm, nonsticky and nonplastic; few fine roots; very few thin silica cutans on undersides of pendants; Stage II carbonate development with occasional discontinuous carbonate lenses; 70 percent weakly cemented with common thin carbonate coatings and many moderately thick pendants on undersides of rock fragments; 10 percent cobbles and 60 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; gradual wavy boundary. (Unit * and no sample collected)

2Ck 47.6 to 63.0 in. (121 to 160 cm). Light brownish-gray (10YR6/2) extremely gravelly coarse sand, dark yellowish-brown (10YR4/4) moist; single grain with distinct relict bedding; slightly hard, friable, nonsticky and nonplastic; few fine roots; very few thin silica cutans on undersides of pendants; Stage I+ carbonate development with few thin discontinuous moderately carbonate-cemented lenses; common thin carbonate coatings and few thin pendants on undersides of rock fragments; 10 percent cobbles and 60 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks. (Unit * and no sample collected)

NOTES: Location was determined by using a Global Positioning System and is accurate to within 30 feet (9 meters). Elevation was determined buy using a field altimeter and is accurate to within 2 feet (0.6 meters). Diagnostic features include an ochric epipedon 0 to 4.3 in. (0 to 11 cm), argillic horizon 4.3 to 13.8 in. (11 to 35 cm), and petrocalcic horizon 13.8 to 33.1 in. (35 to 84 cm). The thickness of the eolian mantle in this pedon is 4.3 in. (11 cm). The argillic horizon contains 3 percent or more clay than the original C horizon parent material is presumed to have contained. This pedon is influenced by a degraded area, presumably a reworked root zone of a large shrub to a depth of 19.7 in. (50 cm), located 15.75 in. (40 cm) to the north-northwest.

SOIL PROFILE ST01-P03

Location: Soil Trench 1, Profile 3, located on the east side of Yucca Flat approximately 2.5 miles (4.0 km) northeast of Soil Trench 3 in the Area 3 RWMS; Nevada State Plane coordinates 8439967 feet north and 697827 feet east; 4287 feet (1307 meters) elevation.

Described by: R. D. Van Remortel and K. E. Snyder

Date described: 17 October 1996

Geomorphic surface: S3

Taxonomic classification of uppermost deposit: Petrocalcid (in Unit *)

Taxonomic classification of pedon: Sandy-skeletal, mixed, thermic Argic Petrocalcids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

A1 0 to 0.8 in. (0 to 2 cm). Pale brown (10YR6/3) extremely gravelly fine sandy loam, yellowish- brown (10YR5/4) moist; strong coarse prismatic structure parting to moderate medium platy; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few very fine vesicular pores; few thin carbonate paleocoatings on sides of rock fragments; 5 percent channer-sized pan fragments, 5 percent cobbles, and 60 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt smooth boundary. (Unit * and no sample collected)

A2 0.8 to 4.3 in. (2 to 11 cm). Very pale brown (10YR7/3) loam, yellowish-brown (10YR5/4) moist; strong coarse prismatic structure parting to weak thick platy; slightly hard, friable, sticky and slightly plastic; few fine roots; common very fine vesicular pores; common irregular hard dark orangish-brown (7.5YR5/8) silica lamina on undersides of structural plates; few thin carbonate paleocoatings on sides of rock fragments; 2 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and no sample collected)

2Btk 4.3 to 7.5 in. (11 to 19 cm). Light brown (7.5YR6/3) very gravelly sandy loam, brown (7.5YR5/3) moist; moderate fine subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common fine and medium roots; common very fine interstitial pores; few thin argillans on contacts between peds and pebbles; very few thin silica cutans on undersides of pan fragments; highly degraded and weathered material exhibiting ancestral Stage III carbonate development; fractures 1 to 5 cm apart; 20 percent moderately carbonate-cemented with troweled lamina on undersides of large pan fragments; common thin carbonate coatings and few thin pendants on undersides of rock fragments; 30 percent pebble-sized pan fragments and 20 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and no sample collected)

2Bkm1 7.5 to 14.1 in. (19 to 36 cm). Pinkish-white (7.5YR8/2) very gravelly sand, light brown (7.5YR6/3) moist; moderate coarse subangular blocky structure; very hard, extremely firm, nonsticky and nonplastic; many thin light brown (7.5YR6/4, 6/6 moist) silica cutans along base of horizon; weakly degraded and weathered material exhibiting ancestral Stage IV carbonate development; fractures 5 to 10 cm apart; light brown (7.5YR6/3, 5/4 moist) 1-mm carbonate lamina capping top of horizon; 90 percent strongly carbonate-cemented with common thin carbonate coatings and many moderately thick pendants on undersides of rock fragments; apparent paleoroot channel of 2-cm diameter and 150-cm length along base of horizon contains light reddish-brown (5YR7/4, 4/6 moist) gravelly sand; 2 percent cobbles and 45 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)

2Bkm2 14.1 to 27.6 in. (36 to 70 cm). Pinkish-white (7.5YR8/2) extremely gravelly coarse sand, light brown (7.5YR6/4) moist; moderate medium subangular blocky structure; extremely hard, slightly rigid, nonsticky and nonplastic; very few thin silica cutans on undersides of pendants; Stage III carbonate development; fractures 30 to 50 cm apart; pink (7.5YR7/3, 6/3 moist) 2-mm carbonate lamina capping top of horizon; 95 percent strongly carbonate-cemented with many thin carbonate coatings and many thick pendants on undersides of rock fragments; 10 percent cobbles and 60 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)

2BCk 27.6 to 45.7 in. (70 to 116 cm). Light brown (7.5YR6/3) extremely gravelly coarse sand, brown (7.5YR5/4) moist; single grain with distinct relict bedding, weak medium subangular blocky structure in some parts; hard, firm, nonsticky and nonplastic; trace of fine roots; very few thin silica cutans on undersides of pendants; Stage II carbonate development with occasional discontinuous moderately carbonate-cemented lenses; 70 percent weakly cemented with common thin carbonate coatings and many moderately thick pendants on undersides of rock fragments; 10 percent cobbles and 60 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; gradual wavy boundary. (Unit * and no sample collected)

2Ck 45.7 to 63.0 in. (116 to 160 cm). Light brownish gray (10YR6/2) extremely gravelly coarse sand, dark yellowish-brown (10YR4/4) moist; single grain with prominent relict bedding; slightly hard, friable, nonsticky and nonplastic; few fine roots; very few thin silica cutans on undersides of pendants; Stage I carbonate development with few thin discontinuous moderately carbonate-cemented lenses; common thin carbonate coatings and very few thin pendants on undersides of rock fragments; 10 percent cobbles and 60 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks. (Unit * and no sample collected)

NOTES: Location was determined by using a Global Positioning System and is accurate to within 30 feet (9 meters). Elevation was determined buy using a field altimeter and is accurate to within 2 feet (0.6 meters). Diagnostic features include an ochric epipedon 0 to 4.3 in. (0 to 11 cm), argillic horizon 4.3 to 7.5 in. (11 to 19 cm), and petrocalcic horizon 7.5 to 27.6 in. (19 to 70 cm). The thickness of the eolian mantle in this pedon is 7.5 in. (11 cm). The argillic horizon contains 3 percent or more clay than the original C horizon parent material is presumed to have contained.

SOIL PROFILE ST01-P04

Location: Soil Trench 1, Profile 4, located on the east side of Yucca Flat, approximately 2.5 miles (4.0 km) northeast of Soil Trench 3 in the Area 3 RWMS; Nevada State Plane coordinates 843958 feet north and 697832 feet east; 4287 feet (1307 meters) elevation.

Described by: R. D. Van Remortel and K. E. Snyder

Date described: 17 October 1996

Geomorphic surface: S3

Taxonomic classification of uppermost deposit: Petrocalcid (in Unit *)

Taxonomic classification of pedon: Sandy-skeletal, mixed, thermic Argic Petrocalcids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

A1 0 to 1.2 in. (0 to 3 cm). Pale brown (10YR6/3) extremely gravelly fine sandy loam, yellowish- brown (10YR5/4) moist; strong coarse prismatic structure parting to moderate medium platy; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; many fine vesicular pores; few thin carbonate paleocoatings on sides of rock fragments; 5 percent channer-sized pan fragments, 5 percent cobbles, and 60 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt smooth boundary. (Unit * and no sample collected)

A2 1.2 to 4.3 in. (3 to 11 cm). Very pale brown (10YR7/3) loam, yellowish-brown (10YR5/4) moist; strong coarse prismatic structure parting to weak thick platy; slightly hard, friable, sticky and slightly plastic; few fine roots; common very fine vesicular pores; common irregular hard dark orangish-brown (7.5YR5/8) silica lamina on undersides of structural plates; few thin carbonate paleocoatings on sides of rock fragments; 2 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and no sample collected)

2Btk1 4.3 to 8.3 in. (11 to 21 cm). Pink (7.5YR7/4) very gravelly sandy loam, strong brown (7.5YR4/6) moist; moderate fine subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common fine and medium roots; common very fine interstitial pores; few thin argillans on contacts between peds and pebbles; very few thin silica cutans on undersides of pan fragments; highly degraded and weathered material exhibiting ancestral Stage III carbonate development; fractures 1 to 5 cm apart; 20 percent moderately carbonate-cemented with troweled lamina on undersides of large pan fragments; common thin carbonate coatings and few thin pendants on undersides of rock fragments; 20 percent pebble-sized pan fragments and 20 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and no sample collected)

2Btk2 8.3 to 11.4 in. (21 to 29 cm). Light brown (7.5YR6/3) very gravelly sandy loam, brown (7.5YR5/4) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and medium roots; few very fine interstitial pores; few thin argillans on contacts between peds and pebbles; very few thin silica cutans on undersides of pan fragments; moderately degraded and weathered material exhibiting ancestral Stage III- carbonate development; fractures 1 to 5 cm apart; few discontinuous 1-mm carbonate lamina throughout; 60 percent weakly to moderately carbonate-cemented with troweled lamina on undersides of large pan fragments; common thin carbonate coatings and few thin pendants on undersides of rock fragments; 30 percent pebble-sized pan fragments, 2 percent cobbles, and 20 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and no sample collected)

2Bkm1 11.4 to 17.0 in. (29 to 43 cm). Pinkish-white (7.5YR8/2) very gravelly sand, light brown (7.5YR6/3) moist; moderate coarse subangular blocky structure; very hard, extremely firm, nonsticky and nonplastic; many thin light brown (7.5YR6/4, 6/6 moist) silica cutans along base of horizon; weakly degraded and weathered material exhibiting ancestral Stage IV carbonate development; fractures 5 to 10 cm apart; light brown (7.5YR6/3, 5/4 moist) 1-mm carbonate lamina capping top of horizon; 90 percent strongly carbonate-cemented with common thin carbonate coatings and many moderately thick pendants on undersides of rock fragments; apparent paleoroot channel of 2-cm diameter and 150-cm length along base of horizon contains light reddish-brown (5YR7/4, 4/6 moist) gravelly sand; 2 percent cobbles and 45 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)

2Bkm2 17.0 to 27.2 in. (43 to 69 cm). Pinkish-white (7.5YR8/2) extremely gravelly coarse sand, light brown (7.5YR6/4) moist; moderate medium subangular blocky structure; extremely hard, slightly rigid, nonsticky and nonplastic; very few thin silica cutans on undersides of pendants; Stage III+ carbonate development; fractures 30 to 50 cm apart; pink (7.5YR7/3, 6/3 moist) 2-mm carbonate lamina capping top of horizon; 95 percent strongly carbonate-cemented with many thin carbonate coatings and many thick pendants on undersides of rock fragments; 10 percent cobbles and 60 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)

2Bk 27.2 to 36.6 in. (69 to 93 cm). Pinkish-white (7.5YR8/2) extremely gravelly coarse sand, light brown (7.5YR6/4) moist; weak medium subangular blocky structure; very hard, very firm, nonsticky and nonplastic; very few thin silica cutans on undersides of pendants; Stage III- carbonate development; fractures 30 to 50 cm apart; 75 percent moderately to strongly carbonate-cemented with many thin carbonate coatings and many moderately thick pendants on undersides of rock fragments; 10 percent cobbles and 60 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)

2BCk 36.6 to 46.4 in. (93 to 118 cm). Pinkish-white (7.5YR8/2) extremely gravelly coarse sand, light brown (7.5YR6/4) moist; single grain within faint relict bedding, weak medium subangular blocky structure in parts; very hard, extremely firm, nonsticky and nonplastic; trace of fine roots; very few thin silica cutans on undersides of pendants; Stage III- carbonate development; fractures 10 to 20 cm apart; 50 percent strongly carbonate-cemented with many thin carbonate coatings and many thick pendants on undersides of rock fragments; large pockets of less-cemented sand and gravel; 10 percent cobbles and 60 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)

2Ck 46.4 to 63.0 in. (118 to 160 cm). Brown (10YR5/3) extremely gravelly coarse sand, dark yellowish- brown (10YR4/4) moist; single grain with distinct relict bedding, weak medium subangular blocky structure in some parts; hard, firm, nonsticky and nonplastic; few fine roots; very few thin silica cutans on undersides of pendants; Stage II carbonate development with few discontinuous moderately carbonate-cemented lenses and paleoroot channels; 70 percent very weakly carbonate-cemented with common thin carbonate coatings and many moderately thick pendants on undersides of rock fragments; 10 percent cobbles and 60 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks. (Unit * and no sample collected)

NOTES: Location was determined by using a Global Positioning System and is accurate to within 30 feet (9 meters). Elevation was determined buy using a field altimeter and is accurate to within 2 feet (0.6 meters). Diagnostic features include an ochric epipedon 0 to 4.3 in. (0 to 11 cm), argillic horizon 4.3 to 11.4 in. (11 to 29 cm), and petrocalcic horizon 11.4 to 36.6 in. (29 to 93 cm). The thickness of the eolian mantle in this pedon is 11 cm. The argillic horizon contains 3 percent or more clay than the original C horizon parent material is presumed to have contained. Surface disturbance by excavation necessitated the interpolation of A1 horizon properties from adjacent undisturbed areas.

SOIL PROFILE ST01-P05

Location: Soil Trench 1, Profile 5, located on the east side of Yucca Flat, approximately 2.5 miles (4.0 km) northeast of Soil Trench 3 in the Area 3 RWMS; Nevada State Plane coordinates 843941 feet north and 697842 feet east; 4287 feet (1307 meters) elevation.

Described by: R. D. Van Remortel and K. E. Snyder

Date described: 16 October 1996

Geomorphic surface: S3

Taxonomic classification of uppermost deposit: Petrocalcid (in Unit *)

Taxonomic classification of pedon: Sandy-skeletal, mixed, thermic Argic Petrocalcids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

A1 0 to 1.2 in. (0 to 3 cm). Pale brown (10YR6/3) extremely gravelly fine sandy loam, yellowish- brown (10YR5/4) moist; moderate medium prismatic structure parting to moderate medium platy; slightly hard, friable, slightly sticky and slightly plastic; trace of fine roots; many fine vesicular pores; few thin carbonate paleocoatings on sides of rock fragments; 10 percent channer-sized pan fragments, 10 percent cobbles, and 50 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt smooth boundary. (Unit * and no sample collected)

A2 1.2 to 3.9 in. (3 to 10 cm). Very pale brown (10YR7/3) very fine sandy loam, brown (10YR5/3) moist; moderate coarse prismatic structure parting to weak thick platy; slightly hard, friable, sticky and plastic; trace of fine roots; many very fine vesicular pores; very few irregular hard dark orangish-brown (7.5YR4/8) silica lamina on undersides of structural plates; few thin carbonate paleocoatings on sides of rock fragments; 2 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and no sample collected)

2Btk 3.9 to 8.3 in. (10 to 21 cm). Light brown (7.5YR6/4) very gravelly sandy loam, strong brown (7.5YR4/6) moist; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and few medium and coarse roots; common very fine interstitial pores; few thin argillans on contacts between peds and pebbles; very few thin silica cutans on undersides of pan fragments; highly degraded and weathered material exhibiting ancestral Stage III carbonate development; fractures 1 to 5 cm apart; 15 percent moderately carbonate-cemented with troweled lamina on undersides of large pan fragments; common thin carbonate coatings and few thin pendants on undersides of rock fragments; 25 percent pebble-sized pan fragments and 20 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)

2Bkm 8.3 to 15.0 in. (21 to 38 cm). Pinkish-gray (7.5YR7/2) very gravelly coarse sand, light brown (7.5YR6/4) moist; moderate fine subangular blocky structure; extremely hard, slightly rigid, nonsticky and nonplastic; few thin light brown (7.5YR6/4, 6/6 moist) silica cutans along base of horizon; weakly degraded and weathered material exhibiting ancestral Stage IV carbonate development; fractures 5 to 10 cm apart; light brown (7.5YR6/4, 5/6 moist) 1-mm carbonate lamina capping top of horizon and in center of horizon; 90 percent strongly carbonate-cemented with common thin carbonate coatings and many thick pendants on undersides of rock fragments; 5 percent cobbles and 50 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and no sample collected)

2Bk 15.0 to 20.9 in. (38 to 53 cm). Pinkish-white (7.5YR8/2) extremely gravelly coarse sand, light brown (7.5YR6/4) moist; moderate medium subangular blocky structure; very hard, extremely firm, nonsticky and nonplastic; very few thin silica cutans on undersides of pendants; Stage II+ carbonate development; fractures 5 to 20 cm apart; 60 percent moderately to strongly carbonate-cemented with many thin carbonate coatings and many thick pendants on undersides of rock fragments; large pockets of less-cemented sand and gravel; 2 percent cobbles and 65 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear irregular boundary. (Unit * and no sample collected)

2BCk 20.9 to 36.6 in. (53 to 93 cm). Pink (7.5YR7/3) extremely gravelly coarse sand, strong brown (7.5YR5/6) moist; single grain with faint relict bedding, weak medium subangular blocky structure in parts; hard, firm, nonsticky and nonplastic; very few thin silica cutans on undersides of pendants; Stage II+ carbonate development; fractures 10 to 20 cm apart; 70 percent weakly cemented with common thin carbonate coatings and many moderately thick pendants on undersides of rock fragments; 2 percent cobbles and 70 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and no sample collected)

2Ck 36.6 to 58.3 in. (93 to 148 cm). Very pale brown (10YR7/3) extremely gravelly coarse sand, yellowish-brown (10YR5/6) moist; single grain with prominent relict bedding; slightly hard, friable, nonsticky and nonplastic; few fine roots; very few thin silica cutans on undersides of pendants; Stage I carbonate development with few thin discontinuous moderately carbonate-cemented lenses; common thin carbonate coatings and very few thin pendants on undersides of rock fragments; 2 percent cobbles and 60 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and no sample collected)

3Bkb 58.3 to 66.9 in. (148 to 170 cm). Pink (7.5YR7/3) very gravelly coarse sand, dark brown (7.5YR4/4) moist; moderate medium subangular blocky structure; hard, firm, nonsticky and nonplastic; Stage II carbonate development; fractures 10 to 20 cm apart; 80 percent weakly carbonate-cemented with many thin carbonate coatings and common moderately thick pendants on undersides of rock fragments; 5 percent cobbles and 35 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks. (Unit * and no sample collected)

NOTES: Location was determined by using a Global Positioning System and is accurate to within 30 feet (9 meters). Elevation was determined buy using a field altimeter and is accurate to within 2 feet (0.6 meters). Diagnostic features include an ochric epipedon 0 to 3.93 in. (0 to 10 cm), argillic horizon 3.9 to 8.27 in. (10 to 21 cm), and petrocalcic horizon 8.27 to 14.96 in. (21 to 38 cm). The thickness of the eolian mantle in this pedon is 3.9 in. (10 cm). The argillic horizon contains 3 percent or more clay than the original C horizon parent material is presumed to have contained. Almost identical to Profile 1 except that this profile has no 2BCk horizon because depth to the paleosol is shallower on this southeast end of the trench. Surface disturbance by excavation necessitated the interpolation of A1 horizon properties from adjacent undisturbed areas.

SOIL PROFILE ST01-P06

Location: Soil Trench 1, Profile 6, located on the east side of Yucca Flat, approximately 2.5 miles (4.0 km) northeast of Soil Trench 3 in the Area 3 RWMS; Nevada State Plane coordinates 843928 feet north and 697849 feet east; 4287 feet (1307 meters) elevation.

Described by: R. D. Van Remortel and K. E. Snyder

Date described: 15 October 1996

Geomorphic surface: S3

Taxonomic classification of uppermost deposit: Petrocalcid (in Unit *)

Taxonomic classification of pedon: Sandy-skeletal, mixed, thermic Argic Petrocalcids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

A1 0 to 0.8 in. (0 to 2 cm). Pale brown (10YR6/3) extremely gravelly sandy loam, dark yellowish- brown (10YR4/4) moist; moderate coarse prismatic structure parting to moderate medium platy; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; many fine vesicular pores; few thin carbonate paleocoatings on sides of rock fragments; 10 percent channer-sized pan fragments, 10 percent cobbles, and 50 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and no sample collected)

A2 0.8 to 5.5 in. (2 to 14 cm). Very pale brown (10YR7/3) very fine sandy loam, yellowish-brown (10YR5/4) moist; moderate coarse prismatic structure parting to weak thick platy; slightly hard, friable, sticky and plastic; few fine roots; many very fine vesicular pores; few irregular hard dark orangish-brown (7.5YR4/8) silica lamina on undersides of structural plates; few thin carbonate paleocoatings on sides of rock fragments; 2 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)

2Btk	5.5 to 9.4 in. (14 to 24 cm). Pink (7.5YR7/4) very gravelly sandy loam, strong brown (7.5YR5/6) moist; moderate fine subangular blocky structure parting to moderate medium granular; slightly hard, friable, slightly sticky and slightly plastic; many fine and few medium and coarse roots; common very fine interstitial pores; few thin argillans on contacts between peds and pebbles; very few thin silica cutans on undersides of pan fragments; highly degraded and weathered material exhibiting ancestral Stage III carbonate development; fractures 0.5 to 5 cm apart; 15 percent moderately carbonate-cemented with troweled lamina on undersides of large pan fragments; common thin carbonate coatings and few thin pendants on undersides of rock fragments; 25 percent pebble-sized pan fragments and 20 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)
2Bkm1	9.4 to 14.6 in. (24 to 37 cm). Pinkish-gray (7.5YR7/2) very gravelly coarse sand, light brown (7.5YR6/4) moist; moderate fine subangular blocky structure; extremely hard, slightly rigid, nonsticky and nonplastic; few thin light brown (7.5YR6/4, 6/6 moist) silica cutans along base of horizon; weakly degraded and weathered material exhibiting ancestral Stage IV carbonate development; fractures 5 to 10 cm apart; light brown (7.5YR6/4, 5/6 moist) 1-mm carbonate lamina capping top of horizon and in center of horizon; 90 percent strongly carbonate-cemented with common thin carbonate coatings and many thick pendants on undersides of rock fragments; 5 percent cobbles and 50 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and no sample collected)
2Bkm2	14.6 to 18.1 in. (37 to 46 cm). Pinkish-white (7.5YR8/2) extremely gravelly sand, pink (7.5YR7/4) moist; moderate fine subangular blocky structure; extremely hard, slightly rigid, nonsticky and nonplastic; trace of very fine roots; very few thin silica cutans on undersides of pendants; Stage IV carbonate development; fractures 30 to 60 cm apart; pink (7.5YR7/4, 6/4 moist) 2-mm carbonate lamina capping top of horizon; 95 percent strongly carbonate-cemented with many thin carbonate coatings and many thick pendants on undersides of rock fragments; 2 percent cobbles and 65 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; gradual wavy boundary. (Unit * and no sample collected)
2Bk	18.1 to 25.2 in. (46 to 64 cm). Pinkish-white (7.5YR8/2) extremely gravelly coarse sand, light brown (7.5YR6/4) moist; moderate medium subangular blocky structure; very hard, extremely firm, nonsticky and nonplastic; very few thin silica cutans on undersides of pendants; Stage III carbonate development; fractures 5 to 20 cm apart; 60 percent moderately to strongly carbonate-cemented with many thin carbonate coatings and many thick pendants on undersides of rock fragments; large pockets of less-cemented sand and gravel; 2 percent cobbles and 65 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)

2BCk 25.2 to 39.8 in. (64 to 101 cm). Pink (7.5YR7/3) extremely gravelly coarse sand, strong brown (7.5YR5/6) moist; single grain with faint relict bedding, weak medium subangular blocky structure in parts; hard, firm, nonsticky and nonplastic; very few thin silica cutans on undersides of pendants; Stage II+ carbonate development; fractures 10 to 20 cm apart; 70 percent weakly cemented with common thin carbonate coatings and many moderately thick pendants on undersides of rock fragments; 2 percent cobbles and 70 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit * and no sample collected)

3Bkb1 39.8 to 48.0 in. (101 to 122 cm). Pink (7.5YR7/4) very gravelly coarse sand, reddish-yellow (7.5YR6/6) moist; moderate medium subangular blocky structure; hard, firm, nonsticky and nonplastic; Stage II carbonate development; fractures 10 to 20 cm apart; 80 percent weakly carbonate-cemented with many thin carbonate coatings and common moderately thick pendants on undersides of rock fragments; 5 percent cobbles and 35 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit * and no sample collected)

3Bkb2 48.0 to 63.0 in. (122 to 160 cm). Pink (7.5YR7/3) very gravelly sand, brown (7.5YR5/4) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; Stage I+ carbonate development; common thin carbonate coatings and common thin pendants on undersides of rock fragments; 5 percent cobbles and 45 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks. (Unit * and no sample collected)

NOTES: Location was determined by using a Global Positioning System and is accurate to within 30 feet (9 meters). Elevation was determined buy using a field altimeter and is accurate to within 2 feet (0.6 meters). Diagnostic features include an ochric epipedon 0 to 5.5 in. (0 to 14 cm), argillic horizon 5.5 to 9.45 in. (14 to 24 cm), and petrocalcic horizon 9.45 to 25.2 in. (24 to 64 cm). The thickness of the eolian mantle in this pedon is 5.5 in. (14 cm). The argillic horizon contains 3 percent or more clay than the original C horizon parent material is presumed to have contained. Almost identical to Profile 1 except that this profile has no 2BCk horizon because depth to the paleosol is shallower on this southeast end of the trench. Surface disturbance by excavation necessitated the interpolation of A1 horizon properties from adjacent undisturbed areas.

SOIL TRENCH 2 – ST02-P01 THROUGH ST02-P07

SOIL PROFILE ST02-P01

Location: Soil Trench 2, Profile 1, located 6.2 feet (1.9 meters) from northwest stake along trench wall of fan piedmont on east side of Yucca Flat upslope from NTS Area 3 RWMS; Nevada State Plane coordinates 843103.5 feet north and 691438.1 feet east; 4124.5 feet (1257.1 meters) elevation.

Described by: R. D. Van Remortel

Sampled by: R. D. Van Remortel

Date described / sampled: 22 October 1996 / 3 February 1997

Geomorphic surface: S5b*

Taxonomic classification of uppermost deposit: Haplocambid (in Unit *)

Taxonomic classification of pedon: Sandy-skeletal, mixed, thermic Argic Petrocalcids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

A 0 to 2.4 in. (0 to 6 cm). Pale brown (10YR6/3) gravelly loamy sand, dark yellowish-brown (10YR3/4) moist; weak coarse prismatic structure parting to moderate thin platy; soft, very friable, nonsticky and nonplastic; few fine roots; common very fine vesicular pores; few thin paleocarbonate coatings on sides of rock fragments; 25 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit Z and sample 01a*)

AB 2.4 to 5.5 in. (6 to 14 cm). Light yellowish-brown (10YR6/4) loamy sand, dark yellowish-brown (10YR4/4) moist; weak coarse prismatic structure parting to weak medium subangular blocky; soft, very friable, nonsticky and nonplastic; common very fine roots; few fine interstitial pores; few thin paleocarbonate coatings on sides of rock fragments; 5 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit Z and sample 01b*)

Bkb1 5.5 to 15.0 in. (14 to 38 cm). Pink (7.5YR7/3) gravelly sandy loam, strong brown (7.5YR4/6) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; Stage I- carbonate development; few thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 1 percent cobbles and 20 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; gradual wavy boundary. (Unit Y and sample 02*)

Bkb2 15.0 to 22.0 in. (38 to 56 cm). Pink (7.5YR7/3) very gravelly sandy loam, strong brown (7.5YR5/6) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; common fine and medium roots; very few thin silica cutans on undersides of rock fragments; Stage I- carbonate development; common thin carbonate coatings on undersides of rock fragments; 2 percent cobbles and 40 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit Y and sample 03*)

BCkb 22.0 to 28.0 in. (56 to 71 cm). Light brown (7.5YR6/4) very gravelly loamy sand, brown (7.5YR5/4) moist; single grain with areas of very faint relict bedding; loose, nonsticky and nonplastic; few fine and medium roots; very few thin silica coatings on undersides of rock fragments; Stage I- carbonate development; common thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 2 percent cobbles and 45 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit Y and sample 04*)

2Btkb 28.0 to 35.0 in. (71 to 89 cm). Pink (7.5YR8/3) very gravelly loamy sand, strong brown (7.5YR5/6) moist; strong fine subangular blocky structure; very hard, extremely firm, nonsticky and nonplastic; trace of fine and medium roots; few thin argillans on contacts between peds and pebbles; very few thin silica cutans on undersides of rock fragments; weakly degraded and weathered material exhibiting ancestral Stage III carbonate development; 85 percent moderately to strongly carbonate-cemented with common moderately thick pendants on undersides of rock fragments; 2 percent cobbles and 40 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit X2 and sample 05*)

2Bkmb 35.0 to 47.2 in. (89 to 120 cm). Pinkish-white (7.5YR8/2) very gravelly loamy sand, light brown (7.5YR6/4) moist; strong medium platy structure parting to moderate medium subangular blocky; extremely hard, slightly rigid, nonsticky and nonplastic; Stage III+ carbonate development; pink (7.5YR7/4, 6/4 moist) 2-mm carbonate lamina capping horizon and 1-mm lamina recurring along major lateral fractures throughout; 95 percent strongly carbonate-cemented with many thin carbonate coatings and many moderately thick pendants on undersides of rock fragments; 1 percent cobbles and 35 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit X2 and sample 06*)

2Bkb1 47.2 to 57.1 in. (120 to 145 cm). Pink (7.5YR7/3) very gravelly loamy sand, strong brown (7.5YR5/6) moist; weak medium subangular blocky structure; hard, firm, nonsticky and nonplastic; few fine roots; Stage I+ carbonate development; 20 percent weakly carbonate-cemented with many thin pendants on undersides of rock fragments; 2 percent cobbles and 40 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; gradual wavy boundary. (Unit X2 and sample 07*)

2Bkb2 57.1 to 62.6 in. (145 to 159 cm). Pinkish-white (7.5YR8/2) very gravelly sand, light brown (7.5YR6/4) moist; weak coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine roots; Stage II- carbonate development; 20 percent weakly carbonate-cemented with common thin carbonate coatings and pendants on undersides of rock fragments; 2 percent cobbles and 35 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; gradual wavy boundary. (Unit X2 and sample 08a*)

2Bkb3 62.6 to 69.3 in. (159 to 176 cm). Pink (7.5YR7/3) very gravelly loamy sand, brown (7.5YR5/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine roots; Stage I carbonate development; few thin carbonate coatings and pendants on undersides of rock fragments; 2 percent cobbles and 35 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit X2 and sample 08b*)

2BCkb 69.3 to 75.6 in. (176 to 192 cm). Pink (7.5YR7/3) very gravelly sand, strong brown (7.5YR5/6) moist; single grain with faint relict bedding, weak medium subangular blocky structure in parts; hard, firm, nonsticky and nonplastic; very few thin argillans on contacts between peds and pebbles; very few thin silica cutans on undersides of rock fragments; Stage I+ carbonate development; numerous discontinuous thin moderately carbonate-cemented lenses with 1-mm lamina throughout and few thin pendants on undersides of rock fragments; common thin paleocarbonate coatings on sides of rock fragments; 5 percent cobbles and 45 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit X2 and sample 09*)

2B'tkb 75.6 to 82.3 in. (192 to 209 cm). Pink (7.5YR7/4) gravelly loamy sand, strong brown (7.5YR5/6) moist; strong fine and medium angular blocky structure; very hard, very firm, nonsticky and nonplastic; few thin argillans on faces of peds; Stage II+ carbonate development; pink (7.5YR7/4, 6/4 moist) discontinuous 1-mm carbonate lamina capping horizon; 40 percent moderately carbonate-cemented with common thin carbonate coatings and few thin pendants on undersides of rock fragments; 2 percent cobbles and 25 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit X2 and sample 10*)

3Btkmb 82.3 to 94.5 in. (209 to 240 cm). Pink (7.5YR7/3) very gravelly loamy sand, brown (7.5YR5/4) moist; moderate fine and medium subangular blocky structure; extremely hard, slightly rigid, nonsticky and nonplastic; common thin argillans on faces of peds; Stage III carbonate development; discontinuous 1-mm carbonate lamina at top of horizon; 90 percent strongly carbonate-cemented with many thin carbonate coatings and few thin pendants on undersides of peds and rock fragments; 5 percent cobbles and 45 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit W2 and sample 11*)

3Bkb1 94.5 to 102.8 in. (240 to 261 cm). Pink (7.5YR8/3) very gravelly loamy sand, light brown (7.5YR6/4) moist; moderate thin platy structure parting to moderate fine subangular blocky; hard, firm, nonsticky and nonplastic; Stage II carbonate development; 80 percent moderately carbonate-cemented with several discontinuous 1-mm carbonate lamina throughout and common thin pendants on undersides of rock fragments; 2 percent cobbles and 55 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; gradual irregular boundary. (Unit W2 and sample 12)

3Bkb2 102.8 to 108.3 in. (261 to 275 cm). Pink (7.5YR7/3) very gravelly loamy sand, brown (7.5YR5/4) moist; weak coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; Stage I+ carbonate development; discontinuous 1-mm carbonate lamina at top of horizon; common moderately thick pendants on undersides of rock fragments; 2 percent cobbles and 45 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit W1 and sample 13)

3B'kmb 108.3 to 114.2 in. (275 to 290 cm). Pinkish-gray (7.5YR7/2) gravelly sand, light brown (7.5YR6/3) moist; strong thin platy structure parting to moderate fine subangular blocky; rigid, nonsticky and nonplastic; Stage IV carbonate development; pink (7.5YR7/4, 6/4 moist) 2-mm carbonate lamina capping horizon; 95 percent very strongly carbonate-cemented with many thin carbonate coatings and many moderately thick pendants on undersides of rock fragments; 25 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks. (Unit W1 and no sample collected*)

NOTES: Bench break at 59 in. (150 cm). Location was determined by triangulation using surveyed reference stakes and is accurate to within 0.25 feet (0.08 meters). Elevation was determined from surveyed reference elevations and is accurate to within 0.1 feet (0.03 meters). Diagnostic features include an ochric epipedon 0 to 5.5 in. (0 to 14 cm), argillic horizon 28 to 35 in. (71 to 89 cm), petrocalcic horizon 35 to 47.25 in. (89 to 120 cm), and calcic horizon 47.25 to 57.1 in. (120 to 145 cm). Located within apparent turbation zone.

SOIL PROFILE ST02-P02

Location: Soil Trench 2, Profile 2, located 47.6 feet (14.5 meters) from northwest stake along trench wall of fan piedmont on east side of Yucca Flat upslope from NTS Area 3 RWMS; Nevada State Plane coordinates 843083.9 feet north and 691474.5 feet east; 4124.1 feet (1257.0 meters) elevation.

Described by: R. D. Van Remortel

Sampled by: not sampled

Date described / sampled: 24 October 1996 / not sampled

Geomorphic surface: S7*

Taxonomic classification of uppermost deposit: Torriorthent (in Unit *)

Taxonomic classification of pedon: Sandy-skeletal, mixed, thermic Argic Petrocalcids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

AC 0 to 3.1 in. (0 to 8 cm). Pale brown (10YR6/3) very gravelly sand, dark yellowish-brown (10YR4/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; few fine roots; few thin paleocarbonate coatings on sides of rock fragments; 3 percent cobbles and 35 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit Z)

C 3.1 to 5.1 in. (8 to 13 cm). Light gray (10YR7/2) very gravelly coarse sand, pale brown (10YR6/3) moist; single grain with faint relict bedding, weak thin platy structure in parts; soft, very friable, nonsticky and nonplastic; common fine roots; few thin paleocarbonate coatings on sides of rock fragments; 2 percent cobbles and 40 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit Z)

Bkb1	5.1 to 10.6 in. (13 to 27 cm). Pale brown (10YR6/3) gravelly loamy sand, yellowish-brown (10YR5/4) moist; weak medium platy structure parting to weak medium subangular blocky; slightly hard, friable, nonsticky and nonplastic; common fine and medium roots; few fine interstitial pores; Stage I carbonate development; common very fine soft carbonate masses and common thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 15 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit Y)
Bkb2	10.6 to 17.7 in. (27 to 45 cm). Pink (7.5YR7/3) gravelly loamy sand, strong brown (7.5YR5/6) moist; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine roots; Stage I carbonate development; common thin carbonate coatings on undersides of rock fragments; 30 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit Y)
2Btkb	17.7 to 26.4 in. (45 to 67 cm). Pink (7.5YR7/3) very gravelly loamy sand, strong brown (7.5YR6/6) moist; strong fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine roots; few thin argillans on contacts between peds and pebbles; few thin silica cutans on undersides of pan fragments; highly degraded and weathered material exhibiting ancestral Stage III carbonate development; 90 percent weakly to moderately carbonate-cemented with many thin pendants on undersides of rock fragments; 25 percent pebble-sized pan fragments and 30 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit X2)
2Bkmb	26.4 to 37.4 in. (67 to 95 cm). Pinkish-white (7.5YR8/2) very gravelly loamy sand, light brown (7.5YR6/4) moist; strong medium platy structure parting to moderate medium subangular blocky; extremely hard, slightly rigid, nonsticky and nonplastic; trace of fine roots; very few thin silica cutans on undersides of rock fragments; Stage III+ carbonate development; pink (7.5YR7/4, 6/4 moist) 2-mm carbonate lamina capping horizon and 1-mm lamina recurring along major lateral fractures throughout; 95 percent strongly carbonate-cemented with many thin carbonate coatings and many moderately thick pendants on undersides of rock fragments; 1 percent cobbles and 35 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit X2)
2Bkb	37.4 to 44.5 in. (95 to 113 cm). Pinkish-white (7.5YR8/2) very gravelly loamy sand, light brown (7.5YR6/4) moist; moderate medium subangular blocky structure; hard, firm, nonsticky and nonplastic; few very fine roots; Stage II carbonate development; 50 percent weakly carbonate-cemented with common thin pendants on undersides of rock fragments; 1 percent cobbles and 35 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit X2)

2BCkb 44.5 to 54.3 in. (113 to 138 cm). Very pale brown (10YR8/4) very gravelly coarse sand, brownish- yellow (10YR6/6) moist; single grain with very faint relict bedding, weak coarse subangular blocky structure in parts; soft, very friable, nonsticky and nonplastic; trace of fine roots; Stage I+ carbonate development; common thin carbonate coatings and pendants on undersides of rock fragments; common thin paleocarbonate coatings on sides of rock fragments; 1 percent cobbles and 45 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; gradual irregular boundary. (Unit X2)

2Ckb1 54.3 to 63.4 in. (138 to 161 cm). Light yellowish-brown (10YR6/4) extremely gravelly coarse sand, dark yellowish-brown (10YR4/6) moist; single grain with prominent relict bedding; slightly hard, friable, nonsticky and nonplastic; Stage I- carbonate development; very weakly cemented in parts, and few thin carbonate coatings and pendants on undersides of rock fragments; common thin paleocarbonate coatings on sides of rock fragments; 2 percent cobbles and 60 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit X2)

2Ckb2 63.4 to 72.0 in. (161 to 183 cm). Light yellowish-brown (10YR6/4) extremely gravelly coarse sand, dark yellowish-brown (10YR4/6) moist; single grain with prominent relict bedding; soft, very friable, nonsticky and nonplastic; Stage I- carbonate development; very weakly cemented at base of horizon, and few thin carbonate coatings and pendants on undersides of rock fragments; common thin paleocarbonate coatings on sides of rock fragments; 2 percent cobbles and 65 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit X2)

3Bkmb 72.0 to 79.1 in. (183 to 201 cm). Pink (7.5YR7/3) very gravelly sand, brown (7.5YR5/4) moist; moderate fine subangular blocky structure; extremely hard, slightly rigid, nonsticky and nonplastic; Stage III carbonate development; pink (7.5YR7/4, 6/4 moist) discontinuous 1-mm carbonate lamina capping horizon; 95 percent strongly carbonate-cemented with many thin carbonate coatings and many moderately thick pendants on undersides of rock fragments; 2 percent cobbles and 40 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit W2)

3Bkb 79.1 to 87.4 in. (201 to 222 cm). Pink (7.5YR7/3) very gravelly coarse sand, brown (7.5YR5/4) moist; weak medium subangular blocky structure; very hard, very firm, nonsticky and nonplastic; Stage II+ carbonate development; 80 percent weakly to moderately carbonate-cemented with many thin carbonate coatings and common thin pendants on undersides of rock fragments; 2 percent cobbles and 55 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit W2)

3BCkb 87.4 to 99.2 in. (222 to 252 cm). Pink (7.5YR8/3) extremely gravelly coarse sand, brown (7.5YR5/4) moist; single grain with very faint relict bedding, weak medium subangular blocky structure in parts; hard, firm, nonsticky and nonplastic; very few thin silica cutans on undersides of rock fragments; Stage II- carbonate development; 40 percent very weakly carbonate-cemented with common thin carbonate coatings and pendants on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 2 percent cobbles and 60 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit W2)

3B'kmb 99.2 to 107.9 in. (252 to 274 cm). Pink (7.5YR8/3) very gravelly loamy sand, light brown (7.5YR6/4) moist; moderate fine subangular blocky structure; rigid, nonsticky and nonplastic; Stage III carbonate development; 90 percent strongly carbonate-cemented with many thin carbonate coatings and many moderately thick pendants on undersides of rock fragments; 2 percent cobbles and 50 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit W1)

3B'kb 107.9 to 114.2 in. (274 to 290 cm). Pink (7.5YR7/4) very gravelly loamy coarse sand, reddish-yellow (7.5YR6/6) moist; weak medium subangular blocky structure; very hard, very firm, nonsticky and nonplastic; very few thin silica cutans on undersides of rock fragments; Stage II+ carbonate development; 60 percent weakly to moderately carbonate-cemented with common thin carbonate coatings and many thin pendants on undersides of rock fragments; 2 percent cobbles and 45 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks. (Unit W1)

NOTES: Bench break at 49.2 in. (125 cm). Location was determined by triangulation using surveyed reference stakes and is accurate to within 0.25 feet (0.08 meters). Elevation was determined from surveyed reference elevations and is accurate to within 0.1 feet (0.03 meters). Diagnostic features include an ochric epipedon 0 to 3.15 in. (0 to 8 cm), argillic horizon 17.7 to 26.38 in. (45 to 67 cm), petrocalcic horizon 26.38 to 37.4 in. (67 to 95 cm), and calcic horizon 37.4 to 44.5 in. (95 to 113 cm). Soil horizons in the lower portion of the profile to the northwest of this location are very different than those in this description. Description in the upper portion of profile not made on mapped trench face due to stream erosion between the time of trench mapping and soil descriptions.

SOIL PROFILE ST02-P03

Location: Soil Trench 2, Profile 3, located 68.6 feet (20.9 meters) from northwest stake along trench wall of fan piedmont on east side of Yucca Flat upslope from NTS Area 3 RWMS; Nevada State Plane coordinates 843073.9 feet north and 691492.9 feet east; 4125.6 feet (1257.5 meters) elevation.

Described by: R. D. Van Remortel

Sampled by: Not sampled

Date described / sampled: 24 October 1996 / not sampled

Geomorphic surface: S5a*

Taxonomic classification of uppermost deposit: Haplocambid (in Unit D*)

Taxonomic classification of pedon: Sandy-skeletal, mixed, thermic Argic Petrocalcids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

A1 0 to 1.2 in. (0 to 3 cm). Very pale brown (10YR7/3) very gravelly fine sandy loam, yellowish- brown (10YR5/4) moist; moderate coarse prismatic structure parting to moderate thin platy; soft, very friable, slightly sticky and slightly plastic; few fine roots; many fine vesicular pores; few thin paleocarbonate coatings on sides of rock fragments; 2 percent cobbles and 35 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt smooth boundary. (Unit Y)

A2 1.2 to 4.3 in. (3 to 11 cm). Light yellowish-brown (10YR6/4) sandy loam, yellowish-brown (10YR5/6) moist; moderate coarse prismatic structure parting to moderate thin and medium platy; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few thin paleocarbonate coatings on sides of rock fragments; 5 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit Y)

Bk1 4.3 to 10.2 in. (11 to 26 cm). Pink (7.5YR7/3) sandy loam, strong brown (7.5YR5/6) moist; moderate coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, nonsticky and slightly plastic; few fine roots; few very fine interstitial pores; Stage I carbonate development; few thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 10 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit Y)

Bk2 10.2 to 18.1 in. (26 to 46 cm). Pink (7.5YR7/3) loamy sand, brown (7.5YR5/4) moist; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots; Stage I carbonate development; common very fine soft masses and common thin carbonate coatings on undersides of rock fragments; 5 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; gradual wavy boundary. (Unit Y)

BCk 18.1 to 33.5 in. (46 to 85 cm). Pink (7.5YR7/3) loamy sand, brown (7.5YR5/4) moist; single grain with faint relict bedding; soft, very friable, nonsticky and nonplastic; few fine and medium roots; Stage I- carbonate development; few thin carbonate coatings on undersides of rock fragments; 5 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit Y)

2Btkb 33.5 to 43.0 in. (85 to 109 cm). Pink (7.5YR7/4) very gravelly sandy loam, strong brown (7.5YR5/6) moist; strong fine subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few fine roots; few thin argillans on contacts between peds and pebbles; moderately degraded and weathered material exhibiting ancestral Stage III carbonate development; 70 percent weakly to moderately carbonate-cemented with many thin pendants on undersides of rock fragments; 30 percent pebble-sized pan fragments, 1 percent cobbles, and 30 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit X2)

2Bkmb 43.0 to 55.5 in. (109 to 141 cm). Pink (7.5YR8/3) very gravelly loamy sand, light brown (7.5YR6/4) moist; moderate medium platy structure parting to strong medium subangular blocky; extremely hard, slightly rigid, nonsticky and nonplastic; few fine roots; very few thin silica cutans on undersides of rock fragments; Stage III+ carbonate development; pink (7.5YR7/4, 6/4 moist) 2-mm carbonate lamina capping horizon and 1-mm lamina recurring along major lateral fractures throughout; 95 percent strongly carbonate-cemented with many thin carbonate coatings and many moderately thick pendants on undersides of rock fragments; 1 percent cobbles and 45 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit X2)

2Bkb1 55.5 to 62.6 in. (141 to 159 cm). Pink (5YR7/3) gravelly sandy loam, yellowish-red (5YR5/6) moist; moderate medium and coarse prismatic structure parting to strong fine and medium subangular blocky; hard, firm, nonsticky and slightly plastic; few very fine roots; very few thin argillans on contacts between peds and pebbles; Stage II carbonate development; 50 percent weakly carbonate-cemented with common thin carbonate coatings and pendants on undersides of rock fragments; 2 percent cobbles and 25 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit X2)

2Bkb2 62.6 to 68.5 in. (159 to 174 cm). Pink (7.5YR7/3) very gravelly loamy sand, brown (7.5YR5/4) moist; moderate medium subangular blocky structure; hard, firm, nonsticky and nonplastic; few very fine roots; Stage I+ carbonate development; common thin carbonate coatings and pendants on undersides of rock fragments; 5 percent cobbles and 50 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit X2)

2BCkb 68.5 to 72.8 in. (174 to 185 cm). Light brown (7.5YR6/3) very gravelly coarse sand, brown (7.5YR4/4) moist; single grain with very faint relict bedding; soft, very friable, nonsticky and nonplastic; trace of fine roots; very few thin silica cutans on undersides of rock fragments; Stage I+ carbonate development; common thin carbonate coatings and pendants on undersides of rock fragments; common thin paleocarbonate coatings on sides of rock fragments; 5 percent cobbles and 50 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; gradual irregular boundary. (Unit X2)

2Ckb 72.8 to 89.0 in. (185 to 226 cm). Light yellowish-brown (10YR6/4) extremely gravelly coarse sand, dark yellowish-brown (10YR4/6) moist; single grain with faint relict bedding; loose, nonsticky and nonplastic; very few thin silica cutans on undersides of rock fragments; Stage I carbonate development; common thin pendants on undersides of rock fragments; common thin paleocarbonate coatings on sides of rock fragments; 2 percent cobbles and 60 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit X2)

3Bkmb 89.0 to 100.8 in. (226 to 256 cm). Pink (7.5YR8/3) very gravelly sand, light brown (7.5YR6/4) moist; strong medium subangular blocky structure; very hard, very firm, nonsticky and nonplastic; few thin silica cutans on undersides of rock fragments; Stage III- carbonate development; 85 percent moderately to strongly carbonate-cemented with common thin carbonate coatings and pendants on undersides of rock fragments; 2 percent cobbles and 45 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit W2)

3Bkb 100.8 to 105.5 in. (256 to 268 cm). Pink (7.5YR7/3) very gravelly coarse sand, brown (7.5YR5/4) moist; moderate medium subangular blocky structure; hard, firm, nonsticky and nonplastic; Stage II carbonate development; 50 percent weakly carbonate-cemented with common thin carbonate coatings and pendants on undersides of rock fragments; 5 percent cobbles and 50 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit W2)

3BCkb 105.5 to 114.2 in. (268 to 290 cm). Pink (7.5YR7/3) very gravelly sand, brown (7.5YR5/4) moist; weak coarse subangular blocky structure, single grain with very faint relict bedding in parts; soft, very friable, nonsticky and nonplastic; very few thin silica cutans on undersides of rock fragments; Stage I+ carbonate development; common thin carbonate coatings and pendants on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 1 percent cobbles and 35 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks. (Unit W2)

NOTES: Bench break at 53.15 in. (135 cm). Location was determined by triangulation using surveyed reference stakes and is accurate to within 0.25 feet (0.08 meters). Elevation was determined from surveyed reference elevations and is accurate to within 0.1 feet (0.03 meters). Diagnostic features include an ochric epipedon 0 to 3.15 in. (0 to 8 cm), argillic horizon 17.7 to 26.38 in. (45 to 67 cm), petrocalcic horizon 26.38 to 37.4 in. (67 to 95 cm), and calcic horizon 37.4 to 44.5 in. (95 to 113 cm). The 3Bkmb here is part of the 15 percent that is not well cemented.

SOIL PROFILE ST02-P04

Location: Soil Trench 2, Profile 4, located 132.6 feet (40.4 meters) from northwest stake along trench wall of fan piedmont on east side of Yucca Flat upslope from NTS Area 3 RWMS; Nevada State Plane coordinates 843043.5 feet north and 691549.2 feet east; 4127.4 feet (1258.0 meters) elevation.

Described by: R. D. Van Remortel

Sampled by: R. D. Van Remortel

Date described / sampled: 24 October 1996 / 4 February 1997

Geomorphic surface: S5a

Taxonomic classification of uppermost deposit: Haplargid (in Unit E*)

Taxonomic classification of pedon: *Loamy-skeletal, mixed, thermic Typic Haplargids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

A1 0 to 0.4 in. (0 to 1 cm). Pale brown (10YR6/3) gravelly fine sandy loam, yellowish-brown (10YR5/4) moist; strong coarse prismatic structure parting to strong thin platy; soft, very friable, slightly sticky and slightly plastic; trace of fine roots; many fine vesicular pores; few thin paleocarbonate coatings on sides of rock fragments; 30 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt smooth boundary. (Unit Y and sample 01a*)

A2 0.4 to 3.9 in. (1 to 10 cm). Light yellowish-brown (10YR6/4) fine sandy loam, dark yellowish- brown (10YR4/6) moist; strong coarse prismatic structure parting to moderate thin platy; slightly hard, friable, slightly sticky and slightly plastic; trace of fine roots; common very fine vesicular pores; very few thin silica cutans on undersides of plates; few thin paleocarbonate coatings on sides of rock fragments; 10 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit Y and sample 01b*)

2Btk 3.9 to 8.7 in. (10 to 22 cm). Light brown (7.5YR6/4) gravelly sandy loam, strong brown (7.5YR4/6) moist; strong coarse prismatic structure parting to moderate fine and medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few fine roots; few very fine vesicular pores; few thin argillans on contacts between peds and pebbles; very few thin silica cutans on undersides of rock fragments; Stage I- carbonate development; few thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 15 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit Y and sample 02*)

2Bk 8.7 to 18.5 in. (22 to 47 cm). Pink (7.5YR7/3) very gravelly loamy sand, brown (7.5YR5/4) moist; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots; Stage I carbonate development; common thin carbonate coatings on undersides of rock fragments; common thin paleocarbonate coatings on sides of rock fragments; 35 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; gradual wavy boundary. (Unit Y and sample 03*)

2BCk 18.5 to 33.5 in. (47 to 85 cm). Pale brown (10YR6/3) very gravelly coarse sand, dark yellowish- brown (10YR4/6) moist; single grain with faint relict bedding; soft, very friable, nonsticky and nonplastic; common fine and medium roots; very few thin silica cutans on undersides of rock fragments; Stage I- carbonate development; few thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 1 percent cobbles and 50 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; gradual wavy boundary. (Unit Y and sample 04*)

2Ck1 33.5 to 65.4 in. (85 to 166 cm). Brown (10YR5/4) extremely gravelly coarse sand with several discontinuous strata of gravelly sand, dark yellowish-brown (10YR4/4) moist; single grain with prominent relict bedding; loose, nonsticky and nonplastic; few fine roots; Stage I- carbonate development; few thin carbonate coatings on undersides of rock fragments; common moderately thick paleocarbonate coatings on sides of rock fragments; 1 percent cobbles and 60 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit Y and sample 05*)

2Ck2 65.4 to 88.2 in. (166 to 224 cm). Pale brown (10YR6/3) gravelly sand with several discontinuous strata of extremely gravelly coarse sand, dark yellowish-brown (10YR4/4) moist; single grain with prominent relict bedding; loose, nonsticky and nonplastic; trace of fine roots; Stage I- carbonate development; few thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; average of 1 percent cobbles and 20 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit Y and sample 06*)

3Bkb 88.2 to 94.1 in. (224 to 239 cm). Pink (7.5YR7/4) very gravelly sandy loam, strong brown (7.5YR5/6) moist; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; trace of fine roots; Stage I+ carbonate development; few thin carbonate coatings and common thin pendants on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 2 percent cobbles and 35 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit X2 and sample 07*)

3BCkb 94.1 to 118.1 in. (239 to 300 cm). Pale brown (10YR6/3) extremely gravelly sand, dark yellowish- brown (10YR4/4) moist; single grain with faint relict bedding; soft, very friable, nonsticky and nonplastic; trace of fine roots; very few thin silica cutans on undersides of rock fragments; Stage I- carbonate development; irregular discontinuous 3-cm weakly carbonate-cemented lenses throughout; common thin paleocarbonate coatings on sides of rock fragments; 2 percent cobbles and
60 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks. (Unit X2 and sample 08*)

NOTES: Bench break at 51.2 in. (130 cm). Location was determined by triangulation using surveyed reference stakes and is accurate to within 0.25 feet (0.08 meters). Elevation was determined from surveyed reference elevations and is accurate to within 0.1 feet (0.03 meters). Diagnostic features include an ochric epipedon 0 to 3.94 in. (0 to 10 cm) and argillic horizon 3.94 to 8.66 in. (10 to 22 cm). The thickness of the eolian mantle in this pedon is 3.94 in. (10 cm). The argillic horizon contains 3 percent or more clay than the original C horizon parent material is presumed to have contained. The 2Ck2 horizon is highly stratified to allow further subdivision.

SOIL PROFILE ST02-P05

Location: Soil Trench 2, Profile 5, located 155.8 feet (47.5 meters) from northwest stake along trench wall of fan piedmont on east side of Yucca Flat upslope from NTS Area 3 RWMS; Nevada State Plane coordinates 843032.5 feet north and 691569.7 feet east; 4127.4 feet (1258.0 meters) elevation.

Described by: R. D. Van Remortel

Sampled by: Not sampled

Date described / Sampled: 7 November 1996 / Not sampled

Geomorphic surface: S4

Taxonomic classification of uppermost deposit: Haplocambid (in Unit D*)

Taxonomic classification of pedon: Sandy-skeletal, mixed, thermic Typic Haplocambids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

A1 0 to 0.8 in. (0 to 2 cm). Light yellowish-brown (10YR6/4) very gravelly sandy loam, dark yellowish-brown (10YR4/4) moist; moderate coarse prismatic structure parting to moderate medium granular; soft, very friable, nonsticky and nonplastic; few fine roots; common very fine vesicular pores; common moderately thick paleocarbonate coatings on sides of rock fragments; 2 percent cobbles and 35 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt smooth boundary. (Unit Y)

A2 0.8 to 7.1 in. (2 to 18 cm). Very pale brown (10YR7/3) gravelly sandy loam, yellowish-brown (10YR5/4) moist; moderate coarse prismatic structure parting to moderate thin platy; slightly hard, friable, nonsticky and slightly plastic; trace of fine roots; many fine vesicular pores; *few thin silica cutans on undersides of plates; few thin paleocarbonate coatings on sides of rock fragments; 15 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit Y)

2Bk1 7.1 to 12.6 in. (18 to 32 cm). Light brown (7.5YR6/4) gravelly sandy loam, strong brown (7.5YR4/6) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots; few fine interstitial pores; Stage I carbonate development; few very fine soft carbonate masses and common thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 5 percent cobbles and 20 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit Y)

2Bk2 12.6 to 22.0 in. (32 to 56 cm). Light brown (7.5YR6/3) very gravelly loamy sand, brown (7.5YR5/4) moist; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; common medium and coarse roots; Stage I- carbonate development; few thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 2 percent cobbles and 40 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; gradual wavy boundary. (Unit Y)

2BCk 22.0 to 29.1 in. (56 to 74 cm). Pale brown (10YR6/3) very gravelly coarse sand, dark yellowish- brown (10YR4/6) moist; single grain with faint relict bedding; soft, very friable, nonsticky and nonplastic; few medium roots; very few thin silica cutans on undersides of rock fragments; Stage I- carbonate development; few thin carbonate coatings and pendants on undersides of rock fragments; common thin paleocarbonate coatings on sides of rock fragments; 1 percent cobbles and 35 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; gradual wavy boundary. (Unit Y)

2Ck 29.1 to 39.4 in. (74 to 100 cm). Pale brown (10YR6/3) very gravelly coarse sand with few discontinuous strata of gravelly sand, dark yellowish-brown (10YR4/4) moist; single grain with prominent relict bedding; soft, very friable, nonsticky and nonplastic; few medium roots; very few thin silica cutans on undersides of rock fragments; Stage I- carbonate development; few thin pendants on undersides of rock fragments; common thin paleocarbonate coatings on sides of rock fragments; 1 percent cobbles and 35 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks. (Unit Y)

NOTES: Location was determined by triangulation using surveyed reference stakes and is accurate to within 0.25 feet (0.08 meters). Elevation was determined from surveyed reference elevations and is accurate to within 0.1 feet (0.03 meters). Diagnostic features include an ochric epipedon 0 to 7.09 in. (0 to 18 cm) and cambic horizon 7.09 to 22.05 in. (18 to 56 cm).

SOIL PROFILE ST02-P06

Location: Soil Trench 2, Profile 6, located 214.6 feet (65.4 meters) from northwest stake along trench wall of fan piedmont on east side of Yucca Flat upslope from NTS Area 3 RWMS; Nevada State Plane coordinates 843004.6 feet north and 691621.4 feet east; 4126.5 feet (1257.8 meters) elevation.

Described by: R. D. Van Remortel

Sampled by: R. D. Van Remortel

Date described / sampled: 14 November 1996 / 4 February 1997

Geomorphic surface: S5a

Taxonomic classification of uppermost deposit: Haplocambid (in Unit C)

Taxonomic classification of pedon: Sandy*, mixed, thermic Typic Haplocambids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

A1 0 to 1.6 in. (0 to 4 cm). Brown (10YR5/3) gravelly fine sandy loam, dark yellowish-brown (10YR3/4) moist; weak coarse prismatic structure parting to moderate thin platy and weak medium granular; soft, very friable, nonsticky and nonplastic; few very fine roots; few fine vesicular pores; few thin paleocarbonate coatings on sides of rock fragments; 1 percent cobbles and 30 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit Y and sample 01a*)

A2 1.6 to 4.3 in. (4 to 11 cm). Brown (10YR5/3) gravelly coarse sandy loam, dark yellowish-brown (10YR4/4) moist; weak coarse prismatic structure parting to moderate thin platy and weak fine granular; slightly hard, friable, nonsticky and nonplastic; few fine roots; common fine vesicular pores; few thin paleocarbonate coatings on sides of rock fragments; 20 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit Y and sample 01b*)

AB 4.3 to 9.1 in. (11 to 23 cm). Light brown (7.5YR6/3) gravelly loamy coarse sand, brown (7.5YR4/4) moist; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common fine and medium roots; few very fine vesicular pores; very few thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 15 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit Y and sample 02a*)

BA 9.1 to 11.8 in. (23 to 30 cm). Light brown (7.5YR6/3) very gravelly loamy coarse sand, brown (7.5YR5/4) moist; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common fine and medium roots; very few thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 35 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit Y and sample 02b*)

Bk1 11.8 to 24.4 in. (30 to 62 cm). Pink (7.5YR7/3) very gravelly loamy coarse sand, strong brown (7.5YR5/6) moist; weak medium subangular blocky structure, very faint relict bedding in parts; slightly hard, friable, nonsticky and nonplastic; few medium and coarse roots; Stage I carbonate development; common thin carbonate coatings on undersides of rock fragments; very few thin paleocarbonate coatings on sides of rock fragments; 1 percent cobbles and 50 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; gradual wavy boundary. (Unit Y and sample 03*)

Bk2 24.4 to 32.3 in. (62 to 83 cm). Pink (7.5YR7/4) gravelly loamy sand, strong brown (7.5YR4/6) moist; weak coarse subangular blocky structure, single grain with very faint relict bedding in parts; soft, very friable, nonsticky and nonplastic; common fine roots; very few thin silica cutans on undersides of rock fragments; Stage I- carbonate development; common thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 1 percent cobbles and 20 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; gradual wavy boundary. (Unit Y and sample 04*)

BCk 32.3 to 47.6 in. (83 to 121 cm). Pink (7.5YR7/4) gravelly sand with few thin discontinuous strata of very gravelly coarse sand, strong brown (7.5YR4/6) moist; single grain within faint relict bedding; soft, very friable, nonsticky and nonplastic; common very fine roots; very few thin silica cutans on undersides of rock fragments; Stage I- carbonate development; common thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 1 percent cobbles and 20 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; gradual wavy boundary. (Unit Y and sample 05*)

Ck 47.6 to 113.8 in. (121 to 289 cm). Very pale brown (10YR7/3) and reddish-yellow (7.5YR7/6) extremely gravelly coarse sand with several thin discontinuous strata of gravelly sand, yellowish-brown (10YR5/6) and strong brown (7.5YR4/6) moist; single grain within distinct relict bedding; loose, nonsticky and nonplastic; few fine and medium roots; very few thin silica cutans on undersides of rock fragments; Stage I carbonate development; 10 percent very weakly carbonate-cemented, with common thin carbonate coatings and few thin pendants on undersides of rock fragments; common thin paleocarbonate coatings on sides of rock fragments; trace of stones, 5 percent cobbles, and 55 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit Y and no sample collected)

2Btkmb 113.8 to 122.0 in. (289 to 310 cm). Pink (5YR7/4) very gravelly loamy sand, yellowish-red (5YR5/6) moist; moderate fine and medium subangular blocky structure; extremely hard, slightly rigid, nonsticky and nonplastic; few thin argillans on contacts between peds and fine pebbles; common thin reddish-yellow (7.5YR7/8, 5/6 moist) silica cutans on sides of rock fragments; Stage III carbonate development; discontinuous 1-mm carbonate lamina capping horizon; 95 percent strongly carbonate-cemented with many thin carbonate coatings and common moderately thick pendants on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 2 percent cobbles and 35 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks. (Unit X2 and no sample collected)

NOTES: Bench break at 59.05 in. (150 cm). Location was determined by triangulation using surveyed reference stakes and is accurate to within 0.25 feet (0.08 meters). Elevation was determined from surveyed reference elevations and is accurate to within 0.1 feet (0.03 meters). Diagnostic features include an ochric epipedon 0 to 4.33 in. (0 to 11 cm) and cambic horizon 11.81 to 32.68 in. (30 to 83 cm). The Ck horizon is highly stratified.

SOIL PROFILE ST02-P07

Location: Soil Trench 2, Profile 7, located 259.5 feet (79.1 meters) from northwest stake along trench wall of fan piedmont on east side of Yucca Flat upslope from NTS Area 3 RWMS; Nevada State Plane coordinates 842983.2 feet north and 691661.0 feet east; 4127.0 feet (1257.9 meters) elevation.

Described by: R. D. Van Remortel

Sampled by: Not sampled

Date described / Sampled: 14 November 1996 / Not sampled

Geomorphic surface: S5a

Taxonomic classification of uppermost deposit: Haplocambid (in Unit D)

Taxonomic classification of pedon: Sandy-skeletal*, mixed, thermic Typic Haplocambids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

A1 0 to 1.6 in. (0 to 4 cm). Pale brown (10YR6/3) gravelly sandy loam, dark yellowish-brown (10YR3/4) moist; weak coarse prismatic structure parting to weak thin platy and weak fine granular; soft, very friable, nonsticky and nonplastic; few very fine roots; few very fine vesicular pores; common thin paleocarbonate coatings on sides of rock fragments; 30 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt smooth boundary. (Unit Y)

A2 1.6 to 3.9 in. (4 to 10 cm). Pale brown (10YR6/3) sandy loam, dark yellowish-brown (10YR4/4) moist; weak coarse prismatic structure parting to moderate thin and medium platy; slightly hard, friable, nonsticky and nonplastic; few fine roots; few very fine vesicular pores; *few thin silica cutans on undersides of rock fragments; common thin paleocarbonate coatings on sides of rock fragments; 10 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit Y)

Bk1	3.9 to 9.4 in. (10 to 24 cm). Light yellowish-brown (10YR6/4) sandy loam, dark yellowish-brown (10YR4/6) moist; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine roots; Stage I- carbonate development; few thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 10 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit Y)
Bk2	9.4 to 14.1 in. (24 to 36 cm). Light yellowish-brown (10YR6/4) gravelly sandy loam, yellowish-brown (10YR5/6) moist; weak fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common medium and coarse roots; Stage I- carbonate development; few thin carbonate coatings on undersides of rock fragments; 20 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit Y)
Bk3	14.1 to 24.4 in. (36 to 62 cm). Pink (7.5YR7/3) gravelly sandy loam, brown (7.5YR5/4) moist; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots; very few thin silica cutans on undersides of rock fragments; Stage I carbonate development; common thin carbonate coatings and few thin pendants on undersides of rock fragments; 25 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; gradual wavy boundary. (Unit Y)
BCk	24.4 to 40.2 in. (62 to 102 cm). Very pale brown (10YR7/3) gravelly loamy sand with few discontinuous strata of very gravelly coarse sand, yellowish-brown (10YR5/6) moist; single grain with very faint relict bedding; soft, very friable, nonsticky and nonplastic; few fine roots; very few thin silica cutans on undersides of rock fragments; Stage I- carbonate development; common thin carbonate coatings and pendants on undersides of rock fragments; 25 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit Y)
Ck	40.2 to 45.7 in. (102 to 116 cm). Pink (7.5YR7/3) very gravelly coarse sand, strong brown (7.5YR5/6) moist; single grain within faint relict bedding; slightly hard, friable, nonsticky and nonplastic; few fine roots; Stage II- carbonate development; discontinuous 1-mm carbonate lamina throughout; 20 percent weakly carbonate-cemented with common thin carbonate coatings and pendants on undersides of rock fragments; common thin paleocarbonate coatings on sides of rock fragments; 5 percent cobbles and 45 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit Y)

Btqkb 45.7 to 50.4 in. (116 to 128 cm). Light reddish-brown (5YR6/3) gravelly sandy loam, reddish-brown (5YR4/4) moist; moderate fine and medium subangular blocky structure; hard, firm, nonsticky and nonplastic; few fine roots; common thin silica cutans on undersides of ped faces and rock fragments; Stage I+ carbonate development; discontinuous 1-mm carbonate lamina throughout; 10 percent very weakly carbonate-cemented, with common carbonate filaments and common thin carbonate coatings on undersides of ped faces and rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 2 percent cobbles and 30 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit Y)

BCkb 50.4 to 62.2 in. (128 to 158 cm). Pinkish-white (7.5YR8/2) very gravelly loamy sand, strong brown (7.5YR5/6) moist; single grain within faint relict bedding; slightly hard, friable, nonsticky and nonplastic; common fine and medium roots; very few thin silica cutans on undersides of rock fragments; Stage II- carbonate development; discontinuous 1-mm carbonate lamina throughout; 60 percent very weakly carbonate-cemented with few thin carbonate coatings and common moderately thick pendants on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 2 percent cobbles and 45 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit Y)

2Bkmb 62.2 to 72.8 in. (158 to 185 cm). Pink (7.5YR7/3) very gravelly loamy sand, strong brown (7.5YR5/6) moist; moderate fine subangular blocky structure; extremely hard, slightly rigid, nonsticky and nonplastic; trace of fine roots; very few thin argillans on contacts between peds and fine pebbles; Stage III carbonate development; nearly continuous 1-mm carbonate lamina capping horizon; 90 percent strongly carbonate-cemented with many thin carbonate coatings and pendants on undersides of rock fragments; 35 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit X2)

2Bkb 72.8 to 82.3 in. (185 to 209 cm). Pink (7.5YR7/3) very gravelly loamy sand, brown (7.5YR5/4) moist; weak medium subangular blocky structure, single grain with very faint relict bedding in pockets at base of horizon; very hard, very firm, nonsticky and nonplastic; trace of fine roots; very few thin silica cutans on undersides of rock fragments; Stage II carbonate development; 70 percent weakly carbonate-cemented with many thin carbonate coatings and pendants on undersides of rock fragments; 2 percent cobbles and 40 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit X2)

3Bkmb 82.3 to 90.6 in. (209 to 230 cm). Pink (7.5YR7/3) very gravelly loamy sand, reddish-yellow (7.5YR6/6) moist; moderate fine subangular blocky structure; extremely hard, slightly rigid, nonsticky and nonplastic; very few thin argillans on contacts between peds and fine pebbles; Stage III carbonate development; 90 percent strongly carbonate-cemented with common thin carbonate coatings and pendants on undersides of rock fragments; 35 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit W2)

3Bkb 90.6 to 96.5 in. (230 to 245 cm). Pink (7.5YR7/3) very gravelly sand, strong brown (7.5YR5/6) moist; weak medium subangular blocky structure; hard, firm, nonsticky and nonplastic; Stage II- carbonate development; 30 percent weakly carbonate-cemented with common thin carbonate coatings and common moderately thick pendants on undersides of rock fragments; 50 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit W2)

3B'kmb 96.5 to 108.3 in. (245 to 275 cm). Pinkish-white (7.5YR8/2) very gravelly loamy sand, light brown (7.5YR6/4) moist; moderate fine subangular blocky structure; very hard, very firm, nonsticky and nonplastic; Stage III+ carbonate development; pink (7.5YR7/4, 6/4 moist) 2-mm carbonate lamina capping horizon and discontinuous 1-mm lamina recurring along major lateral fractures throughout; 95 percent strongly carbonate-cemented with common moderately thick carbonate coatings and pendants on undersides of rock fragments; 55 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit W2)

3B'kb 108.3 to 117.0 in. (275 to 297 cm). Pink (7.5YR7/3) very gravelly loamy sand, strong brown (7.5YR5/6) moist; weak coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; Stage I+ carbonate development; common moderately thick pendants on undersides of rock fragments; 5 percent cobbles and 40 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit W2)

3B''kmb 117.0 to 128.0 in. (297 to 325 cm). Pink (7.5YR7/3) very gravelly loamy sand, strong brown (7.5YR5/6) moist; weak coarse subangular blocky structure; hard, friable, nonsticky and nonplastic; Stage IV- carbonate development; continuous 4-mm carbonate lamina capping horizon; upper 3 cm is strongly cemented and remainder of horizon is 95 percent moderately carbonate-cemented with common thin carbonate coatings and pendants on undersides of rock fragments; 2 percent cobbles and 45 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks. (Unit W2)

NOTES: Bench break at 59.05 in. (150 cm). Location was determined by triangulation using surveyed reference stakes and is accurate to within 0.25 feet (0.08 meters). Elevation was determined from surveyed reference elevations and is accurate to within 0.1 feet (0.03 meters). Diagnostic features include an ochric epipedon 0 to 3.94 in. (0 to 10 cm), cambic horizon 3.94 to 24.41 in. (10 to 62 cm), and petrocalcic horizon 62.2 to 72.8 in. (158 to 185 cm).

SOIL TRENCH 3 – ST03-P01 AND ST03-P02

SOIL PROFILE ST03-P01

Location: Soil Trench 3, Profile 1, located 116.8 feet (35.6 meters) from northwest stake along trench wall inside NTS Area 3 RWMS facility; Nevada State Plane coordinates 835060.9 feet north and 688567.3 feet east; 4012.9 feet (1223.1 meters) elevation.

Described by: R. D. Van Remortel

Sampled by: R. D. Van Remortel

Date described / sampled: 9 December 1996 / 28 January 1997

Geomorphic surface: Disturbed / Not determined

Taxonomic classification of uppermost deposit: Haplocambid (in Unit *)

Taxonomic classification of pedon: Coarse-loamy, mixed, thermic Typic Haplocambids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

Overburden 4.7 to 0 in. (12 to 0 cm). Cover produced by excavation of trench. (not sampled)

Ap1 0 to 1.6 in. (0 to 4 cm). Pale brown (10YR6/3) sandy loam, dark yellowish-brown (10YR4/4) moist; massive with platy and granular appearance; soft, very friable, nonsticky and nonplastic; common very fine roots; few very fine interstitial pores; few thin paleocarbonate coatings on sides of rock fragments; 5 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Spoil and sample 01a*)

Ap2 1.6 to 3.5 in. (4 to 9 cm). Very pale brown (10YR7/4) sandy loam, dark yellowish-brown (10YR4/6) moist; massive and slightly compacted with platy and blocky appearance; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; few very fine interstitial pores; few thin paleocarbonate coatings on sides of rock fragments; 10 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Spoil and sample 01b*)

Ap3	3.5 to 10.2 in. (9 to 26 cm). Pink (7.5YR7/3) loam, strong brown (7.5YR5/6) moist; massive and compacted with prismatic appearance; very hard, very firm, sticky and plastic; few very fine roots in matrix, many fine roots along prism faces; very few very fine vesicular pores at base of horizon; few fine soft carbonate masses and common thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 5 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Spoil and sample 02*)
BA	10.2 to 14.6 in. (26 to 37 cm). Pink (7.5YR7/3) loam, strong brown (7.5YR5/6) moist; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few very fine roots; common very fine vesicular pores; very few thin argillans lining pores and on contacts between ped faces and fine pebbles; Stage I carbonate development; few fine soft carbonate masses and common thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 5 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (N2 and sample 03*)
Bk1	14.6 to 20.5 in. (37 to 52 cm). Light yellowish-brown (10YR6/4) sandy loam, dark yellowish-brown (10YR4/6) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; Stage I- carbonate development; few thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 5 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (N2 and sample 04*)
Bk2	20.5 to 30.3 in. (52 to 77 cm). Pale brown (10YR6/3) fine sandy loam, yellowish-brown (10YR5/4) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; Stage I- carbonate development; few thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 5 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; gradual wavy boundary. (N2 and sample 05*)
BCk1	30.3 to 38.2 in. (77 to 97 cm). Pale brown (10YR6/3) fine sandy loam, dark yellowish-brown (10YR4/4) moist; single grain with very faint relict bedding, weak medium subangular blocky structure in parts; soft, very friable, nonsticky and nonplastic; few very fine roots; Stage I- carbonate development; common thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 5 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (N2 and sample 06*)

BCk2 38.2 to 47.6 in. (97 to 121 cm). Pale brown (10YR6/3) very gravelly coarse sand, yellowish-brown (10YR5/4) moist; single grain within faint relict bedding; loose, nonsticky and nonplastic; few very fine roots; Stage I- carbonate development; common thin carbonate coatings on undersides of rock fragments; common thin paleocarbonate coatings on sides of rock fragments; 45 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit N2 and sample 07*)

BC 47.6 to 74.4 in. (121 to 189 cm). Light yellowish-brown (10YR6/4) very fine sandy loam, dark yellowish-brown (10YR4/6) moist; massive within distinct relict bedding; soft, very friable, slightly sticky and plastic; few very fine roots; few thin paleocarbonate coatings on sides of rock fragments; 2 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit N2 and sample 08*)

BAkb 74.4 to 84.2 in. (189 to 214 cm). Light yellowish-brown (10YR6/4) silt loam, dark yellowish-brown (10YR4/6) moist; weak thin platy structure parting to moderate medium granular; slightly hard, friable, slightly sticky and plastic; common very fine roots; common fine vesicular pores; few carbonate filaments throughout and few thin carbonate coatings on undersides of peds and rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 5 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit N1 and sample 09*)

Bwb 84.2 to 91.3 in. (214 to 232 cm). Light brown (7.5YR6/4) gravelly sandy loam, strong brown (7.5YR4/6) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; trace of very fine roots; few thin paleocarbonate coatings on sides of rock fragments; 15 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit N1 and sample 10*)

Btkb 91.3 to 108.7 in. (232 to 276 cm). Light brown (7.5YR6/4) gravelly loam, strong brown (7.5YR5/6) moist; moderate coarse prismatic structure parting to moderate medium and coarse subangular blocky; hard, firm, slightly sticky and slightly plastic; few fine and medium roots; common thin argillans on contacts between peds and fine pebbles; Stage II carbonate development; 60 percent weakly carbonate-cemented with common carbonate filaments and common thin carbonate coatings on undersides of peds and rock fragments; 15 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit N1 and sample 11*)

BCkb 108.7 to 116.5 in. (276 to 296 cm). Pink (7.5YR7/3) extremely gravelly sandy loam, strong brown (7.5YR5/6) moist; single grain within very faint relict bedding, weak medium subangular blocky structure in parts; slightly hard, friable, nonsticky and nonplastic; Stage II- carbonate development; 30 percent very weakly carbonate-cemented with common discontinuous carbonate zones; common moderately thick pendants and common thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 65 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; gradual wavy boundary. (Unit M and sample 12*)

Ckb 116.5 to 130.0 in. (296 to 330 cm). Light brown (7.5YR6/4) extremely gravelly coarse sand, strong brown (7.5YR5/6) moist; single grain within distinct relict bedding; loose, nonsticky and nonplastic; Stage I carbonate development; few discontinuous carbonate zones; few thin pendants and carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 65 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks. (Unit M and sample 13*)

NOTES: Bench break at 70.87 in. (180 cm). Location was determined by triangulation using surveyed reference stakes and is accurate to within 0.25 feet (0.08 meters). Elevation was determined from surveyed reference elevations and is accurate to within 0.1 feet (0.03 meters). Diagnostic features include a disturbed surface layer 0 to 3.54 in. (0 to 9 cm) and cambic horizon 14.56 to 30.31 in. (37 to 77 cm).

SOIL PROFILE ST03-P02

Location: Soil Trench 3, Profile 2, located 260.8 feet (79.5 meters) from northwest stake along trench wall of fan piedmont inside NTS Area 3 RWMS facility; Nevada State Plane coordinates 835009.7 feet north and 688701.9 feet east; 4012.1 feet (1222.9 meters) elevation.

Described by: R. D. Van Remortel

Sampled by: R. D. Van Remortel

Date described / sampled: 12 December 1996 / 28 January 1997

Geomorphic surface: Disturbed / Not determined

Taxonomic classification of uppermost deposit: Haplocambid (in Unit *)

Taxonomic classification of pedon: Coarse-loamy, mixed, thermic Typic Haplocambids

Remarks: Matrix colors are for crushed and smoothed hand samples, while colors of surface features and concentrations are for undisturbed samples. All colors are for dry conditions unless noted otherwise. The textures given are field-determined.

DESCRIPTION

Overburden 2.4 to 0 in. (6 to 0 cm). Cover produced by excavation of trench. (not sampled)

Ap1 0 to 0.8 in. (0 to 2 cm). Pale brown (10YR5/3) gravelly sandy loam, dark yellowish-brown (10YR3/4) moist; massive with granular appearance; soft, very friable, nonsticky and nonplastic; common fine roots; few fine interstitial pores; few thin paleocarbonate coatings on sides of rock fragments; 1 percent cobbles and 20 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt broken boundary. (Spoil and sample 01a*)

Ap2 0.8 to 4.3 in. (2 to 11 cm). Very pale brown (10YR6/3) sandy loam, dark yellowish-brown (10YR4/4) moist; massive and slightly compacted with platy appearance; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine tubular pores; few thin paleocarbonate coatings on sides of rock fragments; 10 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Spoil and sample 01b*)

Ap3	4.3 to 6.3 in. (11 to 16 cm). Pink (7.5YR7/3) sandy loam, brown (7.5YR5/4) moist; massive and compacted with blocky and granular appearance; hard, firm, slightly sticky and slightly plastic; few very fine roots; very few very fine tubular pores; 5 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Spoil and sample 01c*)
Ap4	6.3 to 7.5 in. (16 to 19 cm). Light brown (7.5YR6/3) gravelly loamy coarse sand, strong brown (7.5YR4/6) moist; massive with blocky appearance; soft, very friable, slightly sticky and plastic; few very fine roots; few very fine tubular pores; few thin paleocarbonate coatings on sides of rock fragments; 15 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Spoil and sample 01d*)
Ap5	7.5 to 15.4 in. (19 to 39 cm). Light brown (7.5YR6/4) sandy loam, strong brown (7.5YR4/6) moist; massive and compacted with prismatic appearance; hard, firm, slightly sticky and plastic; few very fine roots in matrix, many very fine roots along prism faces; few very fine vesicular pores at base of horizon; few fine soft carbonate masses and few thin carbonate coatings on undersides of rock fragments; 5 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Spoil and sample 02*)
BA	15.4 to 21.3 in. (39 to 54 cm). Pink (7.5YR7/4) loam, strong brown (7.5YR5/6) moist; weak thin platy structure parting to weak fine and medium subangular blocky; slightly hard, friable, sticky and plastic; few very fine roots; common very fine vesicular pores; very few thin argillans lining pores and on contacts between ped faces and fine pebbles; common thin carbonate coatings on undersides of peds and rock fragments; 10 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit N2 and sample 03*)
Bk1	21.3 to 29.1 in. (54 to 74 cm). Light brown (7.5YR6/4) gravelly sandy loam, strong brown (7.5YR5/6) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; trace of very fine roots; Stage I- carbonate development; few thin carbonate coatings on undersides of rock fragments; 20 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; gradual wavy boundary. (Unit N2 and sample 04*)
Bk2	29.1 to 37.4 in. (74 to 95 cm). Light brown (7.5YR6/4) gravelly loamy sand, dark brown (7.5YR4/4) moist; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; trace of very fine roots; Stage I- carbonate development; few thin carbonate coatings on undersides of rock fragments; 30 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit N2 and sample 05*)

BCk1 37.4 to 46.1 in. (95 to 117 cm). Pink (7.5YR7/3) and reddish-brown (5YR 5/4) extremely gravelly loamy coarse sand, brown (7.5YR5/4) and reddish-brown (5YR 4/4) moist; single grain within very faint relict bedding; soft, very friable, nonsticky and nonplastic; pockets of common very fine roots in reddish-brown zones; Stage I- carbonate development; few soft carbonate-enriched zones and common thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 65 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit N2 and sample 06*)

BCk2 46.1 to 52.8 in. (117 to 134 cm). Light brown (7.5YR6/3) and reddish-brown (5YR 5/4) very gravelly coarse sand, brown (7.5YR5/4) and reddish-brown (5YR 4/4) moist; single grain with faint relict bedding; loose, nonsticky and nonplastic; pockets of common very fine roots in reddish-brown zones; Stage I- carbonate development; few thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 45 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit N2 and sample 07*)

BCk3 52.8 to 64.2 in. (134 to 163 cm). Light brown (7.5YR6/4) fine sandy loam, brown (7.5YR5/4) moist; massive with very faint relict bedding; soft, very friable, slightly sticky and slightly plastic; few very fine roots; 30 percent of horizon is occupied by slightly hard subangular blocks of older soil suspended in the matrix; blocks range from 2 to 9.8 in. (5 to 25 cm) in diameter and have texture of very fine sandy loam; Stage I carbonate development; common thin carbonate filaments and few fine soft carbonate masses within consolidated zones; few thin paleocarbonate coatings on sides of rock fragments; 40 percent pebbles from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit N2 and sample 08*)

BCk4 64.2 to 69.3 in. (163 to 176 cm). Pink (7.5YR7/3) very gravelly sandy loam, brown (7.5YR5/4) moist; massive within very faint relict bedding, weak coarse subangular blocky structure in parts; soft, very friable, nonsticky and nonplastic; trace of very fine roots; 10 percent of horizon is occupied by slightly hard subangular blocks of older soil suspended in the matrix; blocks range from (.79 to 3.9 in.) 2 to 10 cm in diameter and have texture of fine sandy loam; Stage I carbonate development; common thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 40 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit N2 and sample 09*)

BCk5 69.3 to 78.3 in. (176 to 199 cm). Pink (7.5YR7/3) very fine sandy loam, light brown (7.5YR6/4) moist; massive within very faint relict bedding; soft, very friable, slightly sticky and plastic; few thin paleocarbonate coatings on sides of rock fragments; 1 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit N2 and sample 10*)

BCk6 78.3 to 82.3 in. (199 to 209 cm). Light brown (7.5YR6/3) sandy loam, dark brown (10YR4/4) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few thin carbonate coatings on undersides of rock fragments; few thin paleocarbonate coatings on sides of rock fragments; 2 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt irregular boundary. (Unit N2 and sample 11*)

BAkb 82.3 to 90.2 in. (209 to 229 cm). Light reddish-brown (5YR6/4) very fine sandy loam, yellowish-red (5YR5/6) moist; moderate coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine roots; common very fine vesicular pores; very few thin argillans on contacts between peds and fine pebbles; Stage I carbonate development; common carbonate filaments and few fine soft carbonate masses; 10 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit N1 and sample 12*)

Bkb 90.2 to 96.8 in. (229 to 246 cm). Light brown (7.5YR6/4) coarse sandy loam, strong brown (7.5YR4/6) moist; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; few very fine vesicular pores; very few thin argillans on contacts between peds and fine pebbles; Stage I- carbonate development; few carbonate filaments and few very fine soft carbonate masses; 10 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit N1 and sample 13*)

BCkb 96.8 to 104.0 in. (246 to 264 cm). Light reddish-brown (5YR6/3) gravelly loamy sand, yellowish-red (5YR4/6) moist; weak medium subangular blocky structure, single grain within very faint relict bedding in parts; slightly hard, friable, nonsticky and nonplastic; Stage I- carbonate development; few thin carbonate filaments and few thin carbonate coatings on undersides of rock fragments; 20 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit N1 and sample 14*)

Btkb 104.0 to 113.0 in. (264 to 287 cm). Light brown (7.5YR6/4) gravelly sandy loam, strong brown (7.5YR5/6) moist; weak coarse prismatic structure parting to moderate medium and coarse subangular blocky; hard, firm, slightly sticky and slightly plastic; common thin argillans on contacts between peds and fine pebbles; Stage I carbonate development; common carbonate filaments and few thin carbonate coatings on undersides of rock fragments; 25 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit M and sample 15*)

B'kb 113.0 to 118.5 in. (287 to 301 cm). Pink (7.5YR7/3) gravelly sandy loam, strong brown (7.5YR5/6) moist; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; Stage I carbonate development; few carbonate filaments and common thin carbonate coatings on undersides of rock fragments; 25 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; abrupt wavy boundary. (Unit M and sample 16*)

2Btkb 118.5 to 124.0 in. (301 to 315 cm). Pink (5YR7/3) gravelly loam, reddish-brown (5YR5/4) moist; moderate medium and coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common thin argillans on contacts between peds and fine pebbles; Stage I carbonate development; common carbonate filaments and common thin carbonate coatings on undersides of rock fragments; 20 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks; clear wavy boundary. (Unit M and sample 17*)

2Bkb 124.0 to130.0 in. (315 to 330 cm). Light reddish-brown (5YR6/4) gravelly loamy sand, yellowish-red (5YR4/6) moist; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; Stage I- carbonate development; few thin carbonate coatings on undersides of rock fragments; 30 percent pebbles dominantly from mixed pyroclastic and calcareous sedimentary rocks. (Unit M and sample 18*)

NOTES: Bench break at 68.9 in. (175 cm). Location was determined by triangulation using surveyed reference stakes and is accurate to within 0.25 feet (0.08 meters). Elevation was determined from surveyed reference elevations and is accurate to within 0.1 feet (0.03 meters). Diagnostic features include a disturbed surface layer 0 to 7.5 in. (0 to 19 cm) and cambic horizon 21.26 to 37.4 in. (54 to 95 cm).

APPENDIX D

SOIL CHARACTERIZATION DATABASE

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Batch	Sample	Field Sample Code	Horizon	Upper Depth (cm)	Lower Depth (cm)	Location	Profile	Allostratigraphic Unit	Allostratigraphic Subunit	Lithofacies	Geomorphic Surface	Soil Texture - Lab	Soil Texture - Field	Texture Modifier - Field	Air-Dry Sample Wt. (g)	Air-Dry Fine Earth Wt. (g)	Ground Elevation (ft)	Northing (ft)	Easting (ft)
604	24	EX01P01a01	A1/A2	0	7	EX01	P01	nd	nd	nd	S4	LS	LS/SL	na	6126.7	5499.3	4115	843670	688733
604	2	EX01P01a02	BA	7	21	EX01	P01	nd	nd	nd	S4	LS	SL	na	4746.5	4431.8	4115	843670	688733
604	17	EX01P01a03	2Bk	21	34	EX01	P01	nd	nd	nd	S4	LS	SL	na	4506.0	4258.9	4115	843670	688733
604	9	EX01P01a04	2Btkb	34	42	EX01	P01	nd	nd	nd	S4	LS	L	na	4364.6	4001.4	4115	843670	688733
604	29	EX01P01a05	2Bkb	42	60	EX01	P01	nd	nd	nd	S4	LS	SL	na	6317.9	5312.5	4115	843670	688733
604	18	EX02P01a01	A	0	9	EX02	P01	nd	nd	nd	S5a	LS	LS	GR	6351.6	5318.7	4115	843918	688461
604	10	EX02P01a02	BA	9	25	EX02	P01	nd	nd	nd	S5a	LS	S	GR	6447.6	5430.1	4115	843918	688461
604	3	EX02P01a03	Bk	25	47	EX02	P01	nd	nd	nd	S5a	COS	S	GRV	7132.0	5260.3	4115	843918	688461
604	31	EX02P01a04	BCk	47	60	EX02	P01	nd	nd	nd	S5a	COS	COS	GRV	9225.2	6023.0	4115	843918	688461
604	4	EX03P01a01	A/BAq	0	17	EX03	P01	nd	nd	nd	S4	L	VFSL/L	GRX/GR	8224.6	4943.6	4265	838709	700341
604	25	EX03P01a02	2Btk	17	32	EX03	P01	nd	nd	nd	S4	COSL	SL	GRX	8250.1	2465.5	4265	838709	700341
604	11	EX03P01a03	2Bk1	32	60	EX03	P01	nd	nd	nd	S4	LCOS	LS	GRV	7836.8	2388.8	4265	838709	700341
604	19	EX03P01a04	2Bk2	60	87	EX03	P01	nd	nd	nd	S4	LCOS	SL	GRX	9117.7	2729.5	4265	838709	700341
604	13	EX05P01a01	C1/C2	0	24	EX05	P01	nd	nd	nd	S7	COS	S	GRV	10299.9	4760.6	4250	842796	697574
604	5	EX05P01a02	2BCqkb	24	55	EX05	P01	nd	nd	nd	S7	LCOS	S	GRX	8412.4	2827.6	4250	842796	697574
604	30	EX06P01a01	AC	0	7	EX06	P01	nd	nd	nd	S6	LCOS	S	GRV	10384.5	3703.7	4250	842884	697496
604	20	EX06P01a02	Bw	7	16	EX06	P01	nd	nd	nd	S6	LCOS	S	GRV	10071.3	4783.2	4250	842884	697496
604	26	EX06P01a03	BCk	16	40	EX06	P01	nd	nd	nd	S6	LCOS	S	GRV	9647.3	2470.1	4250	842884	697496
604	21	EX07P01a01	A	0	9	EX07	P01	nd	nd	nd	S5b	LS	LS	GRV	9758.6	5637.8	4250	842944	697443
604	6	EX07P01a02	Bw	9	37	EX07	P01	nd	nd	nd	S5b	LS	LS	GRX	10446.9	5106.4	4250	842944	697443
604	27	EX07P01a03	Bk1	37	63	EX07	P01	nd	nd	nd	S5b	LS	LS	GRV	10331.9	6470.6	4250	842944	697443
604	12	EX07P01a04	Bk2	63	86	EX07	P01	nd	nd	nd	S5b	LS	S	GRV	11368.8	5342.6	4250	842944	697443
604	14	EX07P01a05	BCk	86	100	EX07	P01	nd	nd	nd	S5b	COS	S	GRX	9653.1	3272.8	4250	842944	697443

na=not applicable
nd=not determined

Batch	Sample	Field Sample Code	Horizon	Upper Depth (cm)	Lower Depth (cm)	Location	Profile	Allostratigraphic Unit	Allostratigraphic Subunit	Lithofacies	Geomorphic Surface	Soil Texture - Lab	Soil Texture - Field	Texture Modifier - Field	Air-Dry Sample Wt. (g)	Air-Dry Fine Earth Wt. (g)	Ground Elevation (ft)	Northing (ft)	Easting (ft)
604	15	EX08P01a01	A	0	8	EX08	P01	nd	nd	nd	S5a	LS	LS	GRV	5809.4	3772.5	4125	839515	693632
604	8	EX08P01a02	Bqk	8	25	EX08	P01	nd	nd	nd	S5a	LS	LS	GR	8737.5	6366.8	4125	839515	693632
604	28	EX08P01a03	Bk1	25	43	EX08	P01	nd	nd	nd	S5a	LS	SL	GRV	8757.6	5910.8	4125	839515	693632
604	22	EX08P01a04	Bk2	43	64	EX08	P01	nd	nd	nd	S5a	LS	LS	GRV	10132.3	5525.3	4125	839515	693632
604	1	EX08P01a05	BCqk	64	90	EX08	P01	nd	nd	nd	S5a	COS	S	GRX	9253.5	4363.1	4125	839515	693632

na=not applicable
nd=not determined

Batch	Sample	Field Sample Code	Horizon	Upper Depth (cm)	Lower Depth (cm)	Location	Profile	Allostratigraphic Unit	Allostratigraphic Subunit	Lithofacies	Geomorphic Surface	Soil Texture - Lab	Soil Texture - Field	Texture Modifier - Field	Air-Dry Sample Wt. (g)	Air-Dry Fine Earth Wt. (g)	Ground Elevation (ft)	Northing (ft)	Easting (ft)
702	10	ST02P01a01	A/AB	0	14	ST02	P01	Z	1	a	S5b	LS	LS	na	2990.2	2441.8	4125	843104	691438
702	37	ST02P01a02	2Bkb1	14	38	ST02	P01	Y	-	a,d/b	S5b	LS	SL	GR	2899.5	2092.4	4125	843104	691438
702	6	ST02P01a03	2Bkb2	38	56	ST02	P01	Y	-	d/b	S5b	LS/S	SL	GRV	2694.7	1654.2	4125	843104	691438
702	8	ST02P01a04	2BCkb	56	71	ST02	P01	Y	-	d/b	S5b	S	LS	GRV	5224.9	2246.6	4125	843104	691438
702	16	ST02P01a05	3Btkb	71	89	ST02	P01	X	2	a/d	S5b	SL	LS	GRV	3839.4	2053.0	4125	843104	691438
702	31	ST02P01a06	3Bkmb	89	120	ST02	P01	X	2	a/d,d/b	S5b	LS	LS	GRV	3818.7	1979.3	4125	843104	691438
702	5	ST02P01a07	3Bkb1	120	145	ST02	P01	X	2	d/b	S5b	S/LS	LS	GRV	4070.5	2966.6	4125	843104	691438
702	2	ST02P01a08	3Bkb2/3	145	186	ST02	P01	X	2	d/b	S5b	S	S/LS	GRV	4616.5	2431.5	4125	843104	691438
702	26	ST02P01a09	3BCkb	186	204	ST02	P01	X	2	d	S5b	S	S	GRV	5819.7	3541.6	4125	843104	691438
702	7	ST02P01a10	3B'tkb	204	217	ST02	P01	X	2	a	S5b	LS	LS	GR	3814.5	2651.9	4125	843104	691438
702	3	ST02P01a11	4Btkmb	217	240	ST02	P01	X,W	1,2	a	S5b	SL	LS	GRV	6876.4	3187.3	4125	843104	691438
702	36	ST02P01a12	4Bkb1	240	261	ST02	P01	W	2	a,d/e	S5b	LS	LS	GRV	4280.7	2438.4	4125	843104	691438
702	17	ST02P01a13	4Bkb2	261	275	ST02	P01	W	2	d/e	S5b	LS/S	LS	GRV	4006.1	2464.1	4125	843104	691438
701	10	ST02P04a01	A1/A2	0	10	ST02	P04	Y	-	a	S4	SL	FSL	na	2882.7	2359.8	4127	843044	691549
701	2	ST02P04a02	Btk	10	22	ST02	P04	Y	-	a	S4	SL	SL	GR	3133.6	2239.9	4127	843044	691549
701	3	ST02P04a03	Bk	22	47	ST02	P04	Y	-	d/b	S4	LS	LS	GRV	6085.9	3629.2	4127	843044	691549
701	20	ST02P04a04	BCk	47	85	ST02	P04	Y	-	d/b	S4	S	COS	GRV	6125.7	3429.2	4127	843044	691549
701	18	ST02P04a05	Ck1	85	166	ST02	P04	Y	-	d/b,d	S4	S	COS	GRX	8241.0	2568.9	4127	843044	691549
701	12	ST02P04a06	Ck2	166	224	ST02	P04	Y	-	d/b	S4	LS	S	GR	4099.8	3811.1	4127	843044	691549
701	5	ST02P04a07	2Bkb	224	239	ST02	P04	X	2	b/d	S4	LS	SL	GRV	5092.9	2837.9	4127	843044	691549
701	4	ST02P04a08	2BCkb	239	300	ST02	P04	X	2	b/d	S4	SL	S	GRX	5923.6	2394.8	4127	843044	691549
702	24	ST02P06a01	A1/A2	0	11	ST02	P06	Y	-	a	S5a	SL	FSL/COSL	GR	3516.5	2939.3	4127	843005	691621
702	34	ST02P06a02	AB/BA	11	30	ST02	P06	Y	-	a	S5a	LS	LCOS	GR	4335.9	2993.7	4127	843005	691621

na=not applicable
nd=not determined

Batch	Sample	Field Sample Code	Horizon	Upper Depth (cm)	Lower Depth (cm)	Location	Profile	Allostratigraphic Unit	Allostratigraphic Subunit	Lithofacies	Geomorphic Surface	Soil Texture - Lab	Soil Texture - Field	Texture Modifier - Field	Air-Dry Sample Wt. (g)	Air-Dry Fine Earth Wt. (g)	Ground Elevation (ft)	Northing (ft)	Easting (ft)
702	28	ST02P06a03	Bk1	30	62	ST02	P06	Y	-	d/b	S5a	LS	LCOS	GRV	6446.6	3051.4	4127	843005	691621
702	12	ST02P06a04	Bk2	62	83	ST02	P06	Y	-	d/b	S5a	LS	LS	GR	3476.8	2495.3	4127	843005	691621
702	30	ST02P06a05	BCk	83	121	ST02	P06	Y	-	d	S5a	S	S	GR	4893.7	3830.3	4127	843005	691621
701	17	ST03P01a01	Ap1/2	0	9	ST03	P01	na	na	na	nd	SL/LS	SL	na	3641.9	3357.3	4013	835061	688567
701	9	ST03P01a02	Ap3	9	26	ST03	P01	na	na	na	nd	SL	L	na	2250.3	2068.5	4013	835061	688567
701	14	ST03P01a03	BA	26	37	ST03	P01	N	2	b	nd	SL	L	na	2315.5	2083.4	4013	835061	688567
701	15	ST03P01a04	Bk1	37	52	ST03	P01	N	2	b	nd	SL	SL	na	1505.9	1384.1	4013	835061	688567
701	8	ST03P01a05	Bk2	52	77	ST03	P01	N	2	b	nd	SL	FSL	na	1905.3	1770.4	4013	835061	688567
701	16	ST03P01a06	BCk1	77	97	ST03	P01	N	2	b	nd	LS	FSL	na	2257.4	2038.6	4013	835061	688567
701	22	ST03P01a07	BCk2	97	121	ST03	P01	N	2	d/b	nd	S	COS	GRV	6143.1	3608.5	4013	835061	688567
701	6	ST03P01a08	BC	121	189	ST03	P01	N	2	j	nd	L/SL	VFSL	na	3154.0	3118.4	4013	835061	688567
701	13	ST03P01a09	BAkb	189	214	ST03	P01	N	1	a/b	nd	L	SIL	na	2192.4	2160.4	4013	835061	688567
701	1	ST03P01a10	Bwb	214	232	ST03	P01	N	1	b/d	nd	SL	SL	GR	2310.9	2120.7	4013	835061	688567
701	7	ST03P01a11	2Btkb	232	276	ST03	P01	M	-	a/b	nd	SL	L	GR	2609.5	2159.4	4013	835061	688567
701	19	ST03P01a12	2BCkb	276	296	ST03	P01	M	-	d/b	nd	LS/S	SL	GRX	5359.6	1894.4	4013	835061	688567
701	21	ST03P01a13	2Ckb	296	330	ST03	P01	M	-	d/b	nd	S	COS	GRX	6321.4	3286.9	4013	835061	688567
702	22	ST03P02a01	Ap1/2/3/4	0	19	ST03	P02	na	na	na	nd	SL	SL/LCOS	na	2508.2	2180.4	4012	835010	688702
702	1	ST03P02a02	Ap5	19	39	ST03	P02	na	na	na	nd	SL	SL	na	2833.6	2563.6	4012	835010	688702
702	14	ST03P02a03	BA	39	54	ST03	P02	N	2	a/b	nd	SL	L	na	3118.9	2662.6	4012	835010	688702
702	35	ST03P02a04	Bk1	54	74	ST03	P02	N	2	b	nd	SL	SL	GR	3250.5	2865.8	4012	835010	688702
702	19	ST03P02a05	Bk2	74	95	ST03	P02	N	2	b	nd	LS/S	LS	GR	3244.3	2497.9	4012	835010	688702
702	11	ST03P02a06	BCk1	95	117	ST03	P02	N	2	b,d	nd	S	LCOS	GRX	6121.1	2928.6	4012	835010	688702
702	23	ST03P02a07	BCk2	117	134	ST03	P02	N	2	d	nd	S	COS	GRV	3520.4	2677.0	4012	835010	688702

na=not applicable
nd=not determined

Batch	Sample	Field Sample Code	Horizon	Upper Depth (cm)	Lower Depth (cm)	Location	Profile	Allostratigraphic Unit	Allostratigraphic Subunit	Lithofacies	Geomorphic Surface	Soil Texture - Lab	Soil Texture - Field	Texture Modifier - Field	Air-Dry Sample Wt. (g)	Air-Dry Fine Earth Wt. (g)	Ground Elevation (ft)	Northing (ft)	Easting (ft)
702	38	ST03P02a08	BCk3	134	163	ST03	P02	N	2	j	nd	LS/SL	FSL	na	2854.6	2504.8	4012	835010	688702
702	20	ST03P02a09	BCk4	163	176	ST03	P02	N	2	j	nd	LS	SL	GRV	1548.3	1107.8	4012	835010	688702
702	4	ST03P02a10	BCk5	176	199	ST03	P02	N	2	j	nd	L	VFSL	na	2040.1	2030.8	4012	835010	688702
702	13	ST03P02a11	BCk6	199	209	ST03	P02	N	2	a/b	nd	LS	SL	na	1836.1	1670.9	4012	835010	688702
702	33	ST03P02a12	BAkb	209	229	ST03	P02	N	1	a/b,b/d	nd	SL	VFSL	na	2869.5	2653.5	4012	835010	688702
702	21	ST03P02a13	Bkb	229	246	ST03	P02	N	1	b/d	nd	SL/LS	COSL	na	1900.3	1753.7	4012	835010	688702
702	32	ST03P02a14	BCkb	246	264	ST03	P02	N	1	b/d	nd	S/LS	LS	GR	2709.2	2274.3	4012	835010	688702
702	18	ST03P02a15	2Btkb	264	287	ST03	P02	M	-	a/b	nd	SL	SL	GR	3089.8	2611.5	4012	835010	688702
702	29	ST03P02a16	2B'kb	287	301	ST03	P02	M	-	a/b	nd	SL	SL	GR	2647.7	2176.7	4012	835010	688702
702	15	ST03P02a17	3Btkb	301	315	ST03	P02	L	-	a/b	nd	SL	L	GR	2624.0	2177.6	4012	835010	688702
702	25	ST03P02a18	3Bkb	315	330	ST03	P02	L	-	a/b	nd	LS	LS	GR	2126.0	1754.5	4012	835010	688702
604	16	DBD (RM55G1)*	na	na	na	na	na	na	na	na	na	LS	nd	nd	4275.9	1972.6	3197	768352	707539
702	9	DBD (RM55G1)*	na	na	na	na	na	na	na	na	na	LS	nd	nd	3783.3	1483.0	3197	768352	707539
604	7	RM50F6	na	na	na	na	na	na	na	na	na	LS	nd	nd	5343.4	2713.9	na	na	na
701	11	RM50F6	na	na	na	na	na	na	na	na	na	LS	nd	nd	5000.8	2383.2	na	na	na
604	23	RM50F7	na	na	na	na	na	na	na	na	na	LS	nd	nd	6758.4	3446.6	na	na	na
702	27	RM50F7	na	na	na	na	na	na	na	na	na	LS	nd	nd	6253.3	2965.1	na	na	na

na=not applicable
nd=not determined
*=Sample 410-01 in Lee and others 1996, DOE/NV/11718-073

Batch	Sample	Field Sample Code	Horizon	Upper Depth (cm)	Lower Depth (cm)	Total Pebbles (wt%)	Coarse Pebbles (wt%)	Medium Pebbles (wt%)	Fine Pebbles (wt%)	Total Sand (wt%)	Very Coarse Sand (wt%)	Coarse Sand (wt%)	Medium Sand (wt%)	Fine Sand (wt%)	Very Fine Sand (wt%)	Total Silt (wt%)	Coarse Silt (wt%)	Fine Silt (wt%)	Total Clay (wt%)
604	24	EX01P01a01	A1/A2	0	7	10.2	4.2	3.4	2.7	79.9	4.1	8.9	22.0	30.6	14.3	10.4	2.8	7.6	9.7
604	2	EX01P01a02	BA	7	21	6.6	1.8	2.5	2.3	81.6	3.2	8.3	21.4	31.0	17.6	7.4	2.7	4.7	11.0
604	17	EX01P01a03	2Bk	21	34	5.5	0.3	2.3	2.9	84.4	3.8	8.8	21.5	31.4	18.8	7.2	2.8	4.4	8.4
604	9	EX01P01a04	2Btkb	34	42	8.3	1.8	3.1	3.5	84.4	3.0	7.5	21.1	33.7	19.1	6.9	2.5	4.4	8.7
604	29	EX01P01a05	2Bkb	42	60	15.9	3.4	7.0	5.5	84.1	4.1	9.3	21.3	29.2	20.2	8.3	4.7	3.6	7.6
604	18	EX02P01a01	A	0	9	16.3	0.3	7.5	8.5	82.3	6.1	11.9	20.8	24.4	19.2	11.7	6.7	5.0	6.0
604	10	EX02P01a02	BA	9	25	15.7	0.8	6.7	8.3	84.8	7.4	13.7	23.8	23.1	16.7	9.7	5.0	4.7	5.5
604	3	EX02P01a03	Bk	25	47	26.2	0.5	11.6	14.1	88.3	11.5	18.1	26.5	21.4	10.8	6.2	2.6	3.6	5.5
604	31	EX02P01a04	BCk	47	60	34.7	2.6	15.6	16.5	91.0	11.5	26.1	30.8	16.5	6.2	4.1	1.4	2.7	4.9
604	4	EX03P01a01	A/BAq	0	17	39.8	15.6	19.3	4.9	47.7	2.5	4.9	8.3	14.5	17.5	35.2	14.8	20.4	17.1
604	25	EX03P01a02	2Btk	17	32	70.1	31.0	29.6	9.5	75.1	12.0	15.5	16.2	17.7	13.8	14.2	6.4	7.8	10.7
604	11	EX03P01a03	2Bk1	32	60	69.4	32.6	28.3	8.6	85.7	11.9	18.2	21.0	23.0	11.5	9.8	4.2	5.6	4.5
604	19	EX03P01a04	2Bk2	60	87	70.1	24.4	35.1	10.6	80.4	10.6	15.1	18.6	21.7	14.3	11.8	4.9	6.9	7.8
604	13	EX05P01a01	C1/C2	0	24	53.8	1.9	30.9	21.0	87.0	15.9	25.7	21.5	15.6	8.3	8.5	4.7	3.8	4.5
604	5	EX05P01a02	2BCqkb	24	55	66.4	11.6	39.5	15.3	85.3	19.7	20.4	18.1	16.2	10.9	8.6	4.3	4.3	6.1
604	30	EX06P01a01	AC	0	7	64.3	7.4	44.3	12.7	86.3	13.8	22.9	22.8	16.7	10.1	8.3	4.5	3.8	5.4
604	20	EX06P01a02	Bw	7	16	52.5	14.6	25.9	12.0	84.0	16.9	23.2	20.8	14.6	8.6	10.2	4.8	5.4	5.8
604	26	EX06P01a03	BCk	16	40	74.4	20.6	44.1	9.7	86.0	18.7	24.1	20.7	14.3	8.3	9.1	4.7	4.4	4.9
604	21	EX07P01a01	A	0	9	42.2	14.0	22.0	6.2	77.2	6.4	9.5	14.3	23.4	23.5	15.2	8.4	6.8	7.6
604	6	EX07P01a02	Bw	9	37	51.1	35.3	11.4	4.4	82.3	6.9	11.9	18.2	24.9	20.4	11.9	7.1	4.8	5.8
604	27	EX07P01a03	Bk1	37	63	37.4	18.8	13.5	5.1	80.1	5.4	10.4	17.0	26.2	21.2	13.9	8.7	5.2	6.0
604	12	EX07P01a04	Bk2	63	86	53.0	30.9	17.1	5.0	84.6	6.8	13.5	19.0	25.7	19.6	10.3	5.9	4.4	5.1
604	14	EX07P01a05	BCk	86	100	66.1	45.4	16.3	4.4	88.3	10.5	15.9	21.9	26.4	13.6	7.5	4.1	3.4	4.2
604	15	EX08P01a01	A	0	8	35.1	12.3	15.6	7.2	79.7	6.4	9.9	12.6	22.1	28.7	14.9	9.4	5.5	5.4

Batch	Sample	Field Sample Code	Horizon	Upper Depth (cm)	Lower Depth (cm)	Total Pebbles (wt%)	Coarse Pebbles (wt%)	Medium Pebbles (wt%)	Fine Pebbles (wt%)	Total Sand (wt%)	Very Coarse Sand (wt%)	Coarse Sand (wt%)	Medium Sand (wt%)	Fine Sand (wt%)	Very Fine Sand (wt%)	Total Silt (wt%)	Coarse Silt (wt%)	Fine Silt (wt%)	Total Clay (wt%)	
604	8	EX08P01a02	Bqk	8	25	27.1	4.6	15.0	7.6	82.0	7.8	10.4	17.2	24.4	22.2	11.8	6.1	5.7	6.2	
604	28	EX08P01a03	Bk1	25	43	32.5	5.2	17.6	9.7	82.9	9.5	12.4	16.4	24.3	20.3	11.2	6.4	4.8	5.9	
604	22	EX08P01a04	Bk2	43	64	45.5	10.9	24.1	10.5	84.2	9.5	13.7	17.9	24.3	18.8	10.4	5.8	4.6	5.4	
604	1	EX08P01a05	BCqk	64	90	52.8	11.3	28.3	13.3	88.1	15.0	18.6	20.2	21.2	13.1	7.8	4.6	3.2	4.1	

Batch	Sample	Field Sample Code	Horizon	Upper Depth (cm)	Lower Depth (cm)	Total Pebbles (wt%)	Coarse Pebbles (wt%)	Medium Pebbles (wt%)	Fine Pebbles (wt%)	Total Sand (wt%)	Very Coarse Sand (wt%)	Coarse Sand (wt%)	Medium Sand (wt%)	Fine Sand (wt%)	Very Fine Sand (wt%)	Total Silt (wt%)	Coarse Silt (wt%)	Fine Silt (wt%)	Total Clay (wt%)	
702	10	ST02P01a01	A/AB	0	14	18.3	3.6	9.6	5.2	79.7	3.7	7.1	16.0	30.8	22.1	12.2	5.7	6.5	8.1	
702	37	ST02P01a02	2Bkb1	14	38	27.9	3.4	15.1	9.3	83.7	5.0	10.5	18.5	28.6	21.0	8.4	4.3	4.1	7.9	
702	6	ST02P01a03	2Bkb2	38	56	38.6	6.2	20.5	11.9	86.7	9.3	13.4	20.3	25.1	18.7	7.6	4.6	3.0	5.7	
702	8	ST02P01a04	2BCkb	56	71	57.0	12.3	31.0	13.7	87.9	11.2	16.4	24.6	24.4	11.3	5.5	0.0	5.5	6.5	@
702	16	ST02P01a05	3Btkb	71	89	46.5	4.0	19.2	23.3	75.7	5.9	10.8	20.2	24.3	14.5	8.2	1.8	6.4	16.1	
702	31	ST02P01a06	3Bkmb	89	120	48.2	13.1	23.1	11.9	85.8	7.0	11.0	22.2	30.9	14.8	7.3	2.6	4.7	6.9	
702	5	ST02P01a07	3Bkb1	120	145	27.1	3.0	14.0	10.1	88.5	8.6	14.2	26.3	27.1	12.3	5.1	1.7	3.4	6.4	
702	2	ST02P01a08	3Bkb2/3	145	186	47.3	20.8	19.3	7.3	90.6	7.2	13.2	26.6	30.8	12.8	3.9	1.6	2.3	5.5	
702	26	ST02P01a09	3BCkb	186	204	39.1	6.1	21.3	11.8	92.0	10.1	19.3	31.9	23.3	7.4	3.2	0.8	2.4	4.8	
702	7	ST02P01a10	3B'tkb	204	217	30.5	8.7	14.1	7.7	84.0	3.8	9.0	20.3	32.7	18.1	9.2	4.6	4.6	6.8	
702	3	ST02P01a11	4Btkmb	217	240	53.6	23.5	20.8	9.4	78.8	4.5	9.9	21.1	27.8	15.5	12.4	6.4	6.0	8.8	
702	36	ST02P01a12	4Bkb1	240	261	43.0	6.9	24.4	11.8	85.9	5.2	11.7	25.8	29.9	13.3	6.8	1.5	5.3	7.3	
702	17	ST02P01a13	4Bkb2	261	275	38.5	10.4	20.4	7.7	87.2	5.6	11.6	26.3	31.2	12.4	6.9	3.6	3.3	5.9	
701	10	ST02P04a01	A1/A2	0	10	18.1	1.2	12.3	4.6	65.3	2.1	5.9	15.0	24.5	17.8	18.5	7.5	11.0	16.2	
701	2	ST02P04a02	Btk	10	22	28.5	4.2	14.1	10.2	68.8	5.2	8.1	13.4	20.3	21.8	15.9	7.5	8.4	15.3	
701	3	ST02P04a03	Bk	22	47	40.4	16.2	15.0	9.2	84.1	9.6	14.1	20.2	23.6	16.6	10.0	6.2	3.8	5.9	
701	20	ST02P04a04	BCk	47	85	44.0	7.1	21.9	15.0	88.7	14.6	17.7	22.8	22.0	11.6	7.4	3.3	4.1	3.9	
701	18	ST02P04a05	Ck1	85	166	68.8	21.5	35.1	12.2	92.1	19.2	20.1	25.3	21.3	6.2	3.5	1.1	2.4	4.4	
701	12	ST02P04a06	Ck2	166	224	7.1	0.6	3.0	3.5	85.7	3.7	7.5	19.0	35.8	19.7	7.0	3.4	3.6	7.3	
701	5	ST02P04a07	2Bkb	224	239	44.3	9.2	24.2	10.9	84.3	6.2	12.0	25.3	29.0	11.8	5.6	2.3	3.3	10.1	
701	4	ST02P04a08	2BCkb	239	300	59.6	17.4	31.7	10.5	92.3	9.7	18.7	32.4	23.9	7.7	2.2	1.4	0.8	5.5	
702	24	ST02P06a01	A1/A2	0	11	16.4	1.0	7.0	8.4	77.0	6.5	10.7	16.0	22.6	21.2	16.8	8.9	7.9	6.2	
702	34	ST02P06a02	AB/BA	11	30	31.0	5.3	15.1	10.5	84.1	9.7	14.7	21.2	23.2	15.4	7.8	3.4	4.4	8.1	
702	28	ST02P06a03	Bk1	30	62	52.7	14.8	23.6	14.2	86.0	13.5	20.9	25.7	17.7	8.1	4.8	1.4	3.4	9.2	

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size fraction values adjusted

Batch	Sample	Field Sample Code	Horizon	Upper Depth (cm)	Lower Depth (cm)	Total Pebbles (wt%)	Coarse Pebbles (wt%)	Medium Pebbles (wt%)	Fine Pebbles (wt%)	Total Sand (wt%)	Very Coarse Sand (wt%)	Coarse Sand (wt%)	Medium Sand (wt%)	Fine Sand (wt%)	Very Fine Sand (wt%)	Total Silt (wt%)	Coarse Silt (wt%)	Fine Silt (wt%)	Total Clay (wt%)	
702	12	ST02P06a04	Bk2	62	83	28.2	9.9	11.5	6.8	85.6	6.2	13.4	25.3	29.0	11.7	6.9	2.8	4.1	7.5	
702	30	ST02P06a05	BCk	83	121	21.7	0.3	9.4	12.1	91.9	13.8	18.8	28.0	24.1	7.2	4.0	1.2	2.8	4.1	
701	17	ST03P01a01	Ap1/2	0	9	7.8	0.6	2.8	4.5	79.0	5.1	7.7	13.9	29.8	22.5	10.7	3.8	6.9	10.3	
701	9	ST03P01a02	Ap3	9	26	8.1	0.0	4.6	3.5	69.8	4.5	5.9	12.2	27.7	19.5	11.7	0.3	11.4	18.5	
701	14	ST03P01a03	BA	26	37	10.0	0.0	3.0	7.0	71.1	5.4	7.8	14.3	26.4	17.2	13.4	3.6	9.8	15.5	
701	15	ST03P01a04	Bk1	37	52	8.1	0.0	3.0	5.1	76.3	5.1	8.7	15.9	27.2	19.4	13.2	4.9	8.3	10.5	
701	8	ST03P01a05	Bk2	52	77	7.1	0.0	2.2	4.9	77.0	4.9	9.6	16.8	26.5	19.2	14.3	6.1	8.2	8.7	
701	16	ST03P01a06	BCk1	77	97	9.7	0.0	4.6	5.1	85.6	4.9	9.4	19.0	34.9	17.3	8.8	3.5	5.3	5.6	
701	22	ST03P01a07	BCk2	97	121	41.3	2.2	23.0	16.1	93.3	26.1	28.7	21.3	11.8	5.3	3.8	1.3	2.5	2.9	
701	6	ST03P01a08	BC	121	189	1.1	0.0	0.2	1.0	51.3	0.6	1.1	2.9	13.1	33.7	39.3	22.9	16.4	9.4	
701	13	ST03P01a09	BAkb	189	214	1.5	0.0	0.2	1.3	39.7	1.7	2.9	5.6	13.3	16.3	42.0	12.5	29.5	18.3	
701	1	ST03P01a10	Bwb	214	232	8.2	0.0	3.9	4.3	78.6	5.8	8.3	15.2	30.6	18.6	10.6	5.4	5.2	10.8	
701	7	ST03P01a11	2Btkb	232	276	17.2	0.5	8.8	8.0	76.5	7.1	8.9	15.7	28.9	16.0	11.1	3.9	7.2	12.4	
701	19	ST03P01a12	2BCkb	276	296	64.6	12.3	39.5	12.9	88.4	13.4	14.7	22.8	25.4	12.1	5.0	1.9	3.1	6.6	
701	21	ST03P01a13	2Ckb	296	330	48.0	7.7	24.1	16.2	95.3	24.6	28.3	27.4	11.8	3.2	1.9	0.0	1.9	2.8	@
702	22	ST03P02a01	Ap1/2/3/4	0	19	13.1	1.8	1.9	9.4	73.1	9.3	9.0	11.9	25.3	17.6	16.3	5.8	10.5	10.6	
702	1	ST03P02a02	Ap5	19	39	9.5	0.0	3.3	6.3	68.8	4.6	5.6	10.9	26.0	21.7	12.0	3.0	9.0	19.2	
702	14	ST03P02a03	BA	39	54	14.6	0.2	4.8	9.7	68.6	5.1	9.3	14.3	21.7	18.1	14.1	4.7	9.4	17.3	
702	35	ST03P02a04	Bk1	54	74	11.8	0.0	4.7	7.2	75.7	7.1	11.3	16.3	24.2	16.7	12.4	4.4	8.0	11.9	
702	19	ST03P02a05	Bk2	74	95	23.0	4.0	10.1	8.9	87.1	12.5	16.5	24.8	23.1	10.3	7.9	4.2	3.7	5.0	
702	11	ST03P02a06	BCk1	95	117	52.1	8.4	30.3	13.4	93.2	17.1	25.1	29.6	16.7	4.8	3.6	1.6	2.0	3.2	
702	23	ST03P02a07	BCk2	117	134	24.0	0.4	11.2	12.4	88.9	16.6	23.5	27.1	13.7	8.1	6.4	3.4	3.0	4.7	
702	38	ST03P02a08	BCk3	134	163	12.3	0.4	4.0	7.8	79.0	4.9	8.7	17.0	25.7	22.8	13.0	7.0	6.0	8.0	
702	20	ST03P02a09	BCk4	163	176	28.4	0.5	17.8	10.1	79.5	7.9	8.6	13.5	29.1	20.4	12.8	7.2	5.6	7.7	

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size fraction values adjusted

Batch	Sample	Field Sample Code	Horizon	Upper Depth (cm)	Lower Depth (cm)	Total Pebbles (wt%)	Coarse Pebbles (wt%)	Medium Pebbles (wt%)	Fine Pebbles (wt%)	Total Sand (wt%)	Very Coarse Sand (wt%)	Coarse Sand (wt%)	Medium Sand (wt%)	Fine Sand (wt%)	Very Fine Sand (wt%)	Total Silt (wt%)	Coarse Silt (wt%)	Fine Silt (wt%)	Total Clay (wt%)
702	4	ST03P02a10	BCk5	176	199	0.5	0.0	0.1	0.3	51.3	0.3	0.7	2.2	15.4	32.6	40.4	21.3	19.1	8.3
702	13	ST03P02a11	BCk6	199	209	9.0	0.0	4.3	4.7	82.3	6.4	13.7	21.0	25.8	15.3	10.5	4.6	5.9	7.2
702	33	ST03P02a12	BAkb	209	229	7.5	0.0	1.8	5.8	62.6	5.4	9.6	12.9	18.6	16.1	25.1	12.6	12.5	12.3
702	21	ST03P02a13	Bkb	229	246	7.7	0.0	2.7	5.0	78.3	8.6	17.6	21.1	18.7	12.3	13.7	6.0	7.7	8.0
702	32	ST03P02a14	BCkb	246	264	16.1	0.0	6.2	9.9	88.8	10.7	23.5	28.0	19.5	7.0	4.8	1.1	3.7	6.4
702	18	ST03P02a15	2Btkb	264	287	15.5	0.9	6.9	7.7	78.3	6.4	13.3	20.6	24.7	13.4	9.8	4.4	5.4	11.9
702	29	ST03P02a16	2B'kb	287	301	17.8	0.6	7.0	10.3	84.7	9.1	15.4	21.5	26.6	12.1	5.4	1.6	3.8	9.9
702	15	ST03P02a17	3Btkb	301	315	17.0	0.0	4.8	12.2	79.1	8.9	14.6	20.8	24.1	10.7	6.8	1.4	5.4	14.1
702	25	ST03P02a18	3Bkb	315	330	17.5	0.0	7.3	10.2	83.6	8.6	16.6	24.3	24.0	10.0	4.5	1.1	3.4	11.9
604	16	DBD (RM55G1)*	na	na	na	53.8	3.6	49.9	0.3	81.8	7.7	7.3	9.9	32.9	24.0	10.6	5.3	5.3	7.6
702	9	DBD (RM55G1)*	na	na	na	60.8	3.5	56.1	1.2	83.6	7.5	7.0	10.6	35.1	23.5	10.3	5.5	4.8	6.1
604	7	RM50F6	na	na	na	49.2	2.0	31.5	15.7	83.2	7.0	7.0	10.7	34.6	24.0	10.4	5.0	5.4	6.4
701	11	RM50F6	na	na	na	52.3	2.3	32.9	17.1	83.0	8.1	6.5	10.3	34.0	24.0	10.3	5.3	5.0	6.7
604	23	RM50F7	na	na	na	49.0	2.2	29.3	17.6	81.4	8.1	6.9	10.1	31.3	24.9	10.7	5.3	5.4	7.9
702	27	RM50F7	na	na	na	52.6	2.4	29.3	20.8	83.0	7.9	6.8	10.5	33.8	24.1	10.5	5.1	5.4	6.5

na=not applicable
* =Sample 410-01 in Lee and others,1996. DOE/NV/11718-073

Batch	Sample	Field Sample Code	Horizon	Upper Depth (cm)	Lower Depth (cm)	Moist (wt%)	pH	CaCO3_Eq (wt%)	CaCO3_Eq Flag	CBD_Fe (wt%)	CBD_Si (wt%)
604	24	EX01P01a01	A1/A2	0	7	1.11	9.14	1.89		0.303	0.075
604	2	EX01P01a02	BA	7	21	1.63	9.08	3.28		0.235	0.061
604	17	EX01P01a03	2Bk	21	34	1.42	9.12	4.54		0.233	0.057
604	9	EX01P01a04	2Btkb	34	42	1.63	9.02	5.58		0.240	0.063
604	29	EX01P01a05	2Bkb	42	60	1.21	9.14	5.11		0.228	0.061
604	18	EX02P01a01	A	0	9	1.21	8.85	3.04		0.259	0.049
604	10	EX02P01a02	BA	9	25	1.32	9.13	3.98		0.233	0.047
604	3	EX02P01a03	Bk	25	47	1.32	9.05	5.61		0.160	0.048
604	31	EX02P01a04	BCk	47	60	1.11	9.14	4.93		0.135	0.043
604	4	EX03P01a01	A/BAq	0	17	1.32	9.28	20.70		0.367	0.070
604	25	EX03P01a02	2Btk	17	32	1.21	9.02	26.69		0.229	0.064
604	11	EX03P01a03	2Bk1	32	60	1.21	8.63	31.77		0.129	0.066
604	19	EX03P01a04	2Bk2	60	87	1.42	8.35	27.87		0.145	0.064
604	13	EX05P01a01	C1/C2	0	24	0.81	9.17	14.95		0.413	0.044
604	5	EX05P01a02	2BCqkb	24	55	1.21	9.02	16.54		0.285	0.044
604	30	EX06P01a01	AC	0	7	0.60	8.94	14.53		0.380	0.049
604	20	EX06P01a02	Bw	7	16	0.81	9.13	13.69		0.365	0.044
604	26	EX06P01a03	BCk	16	40	0.91	9.13	17.34		0.367	0.045
604	21	EX07P01a01	A	0	9	0.81	8.75	10.20		0.490	0.064
604	6	EX07P01a02	Bw	9	37	1.01	8.96	11.65		0.348	0.051
604	27	EX07P01a03	Bk1	37	63	1.11	9.10	11.34		0.372	0.055
604	12	EX07P01a04	Bk2	63	86	1.21	9.04	13.13		0.306	0.049
604	14	EX07P01a05	BCk	86	100	1.21	9.11	12.77		0.321	0.050
604	15	EX08P01a01	A	0	8	1.01	8.70	8.14		0.417	0.052

Batch	Sample	Field Sample Code	Horizon	Upper Depth (cm)	Lower Depth (cm)	Moist (wt%)	pH	CaCO3_Eq (wt%)	CaCO3_Eq Flag	CBD_Fe (wt%)	CBD_Si (wt%)
604	8	EXO8P01a02	Bqk	8	25	1.11	8.92	11.39		0.321	0.053
604	28	EXO8P01a03	Bk1	25	43	0.91	8.98	13.26		0.318	0.052
604	22	EXO8P01a04	Bk2	43	64	0.81	9.02	13.36		0.327	0.053
604	1	EXO8P01a05	BCqk	64	90	1.11	8.93	15.50		0.216	0.042

Batch	Sample	Field Sample Code	Horizon	Upper Depth (cm)	Lower Depth (cm)	Moist (wt%)	pH	CaCO3_Eq (wt%)	CaCO3_Eq Flag	CBD_Fe (wt%)	CBD_Si (wt%)
702	10	ST02P01a01	A/AB	0	14	0.81	8.91	6.74		0.296	0.055
702	37	ST02P01a02	2Bkb1	14	38	0.60	8.96	10.53		0.224	0.055
702	6	ST02P01a03	2Bkb2	38	56	0.81	9.19	9.68		0.190	0.047
702	8	ST02P01a04	2BCkb	56	71	0.70	8.80	13.87		0.176	0.052
702	16	ST02P01a05	3Btkb	71	89	1.63	8.98	18.67		0.192	0.084
702	31	ST02P01a06	3Bkmb	89	120	1.01	8.54	18.47		0.130	0.073
702	5	ST02P01a07	3Bkb1	120	145	1.01	8.15	10.27		0.140	0.047
702	2	ST02P01a08	3Bkb2/3	145	186	1.01	8.55	12.49		0.148	0.045
702	26	ST02P01a09	3BCkb	186	204	0.91	8.29	12.20		0.150	0.052
702	7	ST02P01a10	3B'tkb	204	217	1.21	8.44	8.62		0.208	0.057
702	3	ST02P01a11	4Btkmb	217	240	1.42	8.15	15.65		0.199	0.057
702	36	ST02P01a12	4Bkb1	240	261	1.01	8.34	20.12		0.135	0.051
702	17	ST02P01a13	4Bkb2	261	275	1.11	8.37	17.78		0.149	0.046
701	10	ST02P04a01	A1/A2	0	10	1.83	8.92	7.46		0.365	0.081
701	2	ST02P04a02	Btk	10	22	2.25	8.88	4.98		0.320	0.081
701	3	ST02P04a03	Bk	22	47	1.63	9.19	7.27		0.195	0.061
701	20	ST02P04a04	BCk	47	85	1.01	8.80	10.82		0.179	0.059
701	18	ST02P04a05	Ck1	85	166	1.52	8.10	6.29		0.165	0.046
701	12	ST02P04a06	Ck2	166	224	1.52	8.38	6.54		0.257	0.045
701	5	ST02P04a07	2Bkb	224	239	1.83	8.25	10.55		0.228	0.057
701	4	ST02P04a08	2BCkb	239	300	1.42	8.26	12.71		0.154	0.046
702	24	ST02P06a01	A1/A2	0	11	0.81	8.88	6.67		0.308	0.055
702	34	ST02P06a02	AB/BA	11	30	1.01	9.00	7.99		0.248	0.046
702	28	ST02P06a03	Bk1	30	62	0.70	9.04	14.00		0.208	0.053

Batch	Sample	Field Sample Code	Horizon	Upper Depth (cm)	Lower Depth (cm)	Moist (wt%)	pH	CaCO3_Eq (wt%)	CaCO3_Eq Flag	CBD_Fe (wt%)	CBD_Si (wt%)
702	12	ST02P06a04	Bk2	62	83	0.91	9.13	9.12		0.184	0.056
702	30	ST02P06a05	BCk	83	121	0.81	9.25	6.95		0.139	0.045
701	17	ST03P01a01	Ap1/2	0	9	1.42	8.91	4.12		0.274	0.073
701	9	ST03P01a02	Ap3	9	26	2.25	8.79	5.88		0.313	0.090
701	14	ST03P01a03	BA	26	37	2.25	9.15	2.89		0.598	0.197
701	15	ST03P01a04	Bk1	37	52	1.83	9.25	2.13		0.550	0.194
701	8	ST03P01a05	Bk2	52	77	1.63	9.39	1.96		0.270	0.087
701	16	ST03P01a06	BCk1	77	97	1.11	9.33	0.97	#	0.250	0.070
701	22	ST03P01a07	BCk2	97	121	1.11	8.24	0.62	#	0.179	0.039
701	6	ST03P01a08	BC	121	189	2.25	8.12	2.56		0.456	0.089
701	13	ST03P01a09	BAkb	189	214	2.67	7.71	5.03		0.426	0.088
701	1	ST03P01a10	Bwb	214	232	2.15	7.67	0.45	#	0.331	0.067
701	7	ST03P01a11	2Btkb	232	276	1.94	7.85	1.07		0.335	0.076
701	19	ST03P01a12	2BCkb	276	296	1.32	7.87	8.41		0.191	0.052
701	21	ST03P01a13	2Ckb	296	330	0.91	8.04	3.14		0.142	0.037
702	22	ST03P02a01	Ap1/2/3/4	0	19	1.21	8.94	7.52		0.319	0.068
702	1	ST03P02a02	Ap5	19	39	1.63	8.90	6.07		0.316	0.075
702	14	ST03P02a03	BA	39	54	1.32	9.11	3.21		0.316	0.074
702	35	ST03P02a04	Bk1	54	74	1.01	9.18	2.22		0.273	0.066
702	19	ST03P02a05	Bk2	74	95	0.60	9.05	2.66		0.221	0.049
702	11	ST03P02a06	BCk1	95	117	0.81	8.34	1.42		0.196	0.043
702	23	ST03P02a07	BCk2	117	134	0.70	8.58	1.69		0.230	0.049
702	38	ST03P02a08	BCk3	134	163	1.11	8.39	1.68		0.288	0.065
702	20	ST03P02a09	BCk4	163	176	1.21	8.33	1.88		0.296	0.058

=less than the lowest calibration standard

Batch	Sample	Field Sample Code	Horizon	Upper Depth (cm)	Lower Depth (cm)	Moist (wt%)	pH	CaCO3_Eq (wt%)	CaCO3_Eq Flag	CBD_Fe (wt%)	CBD_Si (wt%)
702	4	ST03P02a10	BCk5	176	199	1.42	7.97	3.14		0.408	0.070
702	13	ST03P02a11	BCk6	199	209	1.11	8.02	1.08		0.273	0.047
702	33	ST03P02a12	BAkb	209	229	1.52	8.02	3.77		0.334	0.067
702	21	ST03P02a13	Bkb	229	246	1.11	7.88	1.71		0.283	0.053
702	32	ST03P02a14	BCkb	246	264	0.70	8.19	2.90		0.222	0.041
702	18	ST03P02a15	2Btkb	264	287	1.32	8.07	1.70		0.308	0.061
702	29	ST03P02a16	2B'kb	287	301	1.01	7.99	4.91		0.225	0.046
702	15	ST03P02a17	3Btkb	301	315	1.63	8.04	8.34		0.263	0.057
702	25	ST03P02a18	3Bkb	315	330	1.32	8.31	6.08		0.245	0.050
604	16	DBD (RM55G1)*	na	na	na	1.42	9.13	3.23		0.283	0.065
702	9	DBD (RM55G1)*	na	na	na	0.60	8.96	3.22		0.247	0.059
604	7	RM50F6	na	na	na	1.11	8.99	3.41		0.253	0.068
701	11	RM50F6	na	na	na	1.01	8.97	3.56		0.266	0.073
604	23	RM50F7	na	na	na	0.81	9.19	3.09		0.261	0.064
702	27	RM50F7	na	na	na	0.60	9.05	3.07		0.269	0.063

na=not applicable

* =Sample 410-01 in Lee and others,1996. DOE/NV/11718-073

Batch	Sample	Field Sample Code	Horizon	Upper Depth (cm)	Lower Depth (cm)	USCS Group-Lab	Gravel_USCS (wt%)	Sand_USCS (wt%)	Silt+Clay_USCS (wt%)		P < 3-in	P < 2-in	P < 1 1/2-in	P < 1-in	P < 3/4-in	P < 3/8-in	P < #4	P < #10	P < #40	P < #200
604	24	EX01P01a01	A1/A2	0	7	SM	6.7	67.3	26.0		100	99	98	97	96	94	92	90	73	25
604	2	EX01P01a02	BA	7	21	SM	3.9	68.2	27.7		100	99	99	99	98	97	96	93	77	26
604	17	EX01P01a03	2Bk	21	34	SM	2.4	70.7	26.8		100	100	100	100	100	99	97	95	78	25
604	9	EX01P01a04	2Btkb	34	42	SM	4.2	68.8	27.0		100	99	99	99	98	96	95	92	77	24
604	29	EX01P01a05	2Bkb	42	60	SM	8.6	65.7	25.7		100	99	98	97	97	94	90	84	68	23
604	18	EX02P01a01	A	0	9	SM	6.5	68.1	25.4		100	100	100	100	100	96	92	84	64	24
604	10	EX02P01a02	BA	9	25	SM	6.2	70.7	23.0		100	100	100	99	99	96	93	84	61	21
604	3	EX02P01a03	Bk	25	47	SM	9.2	73.6	17.2		100	100	100	100	100	94	88	74	47	13
604	31	EX02P01a04	BCk	47	60	SW-SM	13.1	74.8	12.2		100	99	99	98	97	89	82	65	36	8
604	4	EX03P01a01	A/BAq	0	17	ML	21.7	27.3	50.9		100	95	92	88	84	74	65	60	54	37
604	25	EX03P01a02	2Btk	17	32	SM	30.8	39.5	29.7		100	91	85	75	69	54	39	30	21	10
604	11	EX03P01a03	2Bk1	32	60	SM	30.2	43.9	25.8		100	91	84	74	67	53	39	31	20	6
604	19	EX03P01a04	2Bk2	60	87	SM	30.1	42.3	27.6		100	93	88	81	76	59	41	30	21	8
604	13	EX05P01a01	C1/C2	0	24	SM	19.5	61.5	19.0		100	99	99	98	98	83	67	46	24	8
604	5	EX05P01a02	2BCqkb	24	55	SM	27.9	52.0	20.1		100	97	94	91	88	68	49	34	19	7
604	30	EX06P01a01	AC	0	7	SM	28.9	52.5	18.6		100	98	96	94	93	71	48	36	21	7
604	20	EX06P01a02	Bw	7	16	SM	24.3	55.3	20.5		100	96	93	88	85	72	60	48	26	10
604	26	EX06P01a03	BCk	16	40	SM	33.8	47.8	18.5		100	94	90	84	79	57	35	26	14	5
604	21	EX07P01a01	A	0	9	SM	23.6	47.0	29.4		100	96	93	89	86	75	64	58	47	21
604	6	EX07P01a02	Bw	9	37	SM	28.7	47.0	24.3		100	90	82	72	65	59	53	49	38	14
604	27	EX07P01a03	Bk1	37	63	SM	21.7	50.2	28.1		100	95	91	85	81	74	68	63	50	20
604	12	EX07P01a04	Bk2	63	86	SM	28.9	48.0	23.1		100	91	85	76	69	60	52	47	35	12
604	14	EX07P01a05	BCk	86	100	SM	34.5	48.0	17.5		100	87	77	64	55	47	38	34	23	7
604	15	EX08P01a01	A	0	8	SM	19.5	50.6	29.9		100	96	94	90	88	80	72	65	52	24

Batch	Sample	Field Sample Code	Horizon	Upper Depth (cm)	Lower Depth (cm)	USCS Group-Lab	Gravel_USCS (wt%)	Sand_USCS (wt%)	Silt+Clay_USCS (wt%)		P < 3-in	P < 2-in	P < 1 1/2-in	P < 1-in	P < 3/4-in	P < 3/8-in	P < #4	P < #10	P < #40	P < #200
604	8	EX08P01a02	Bqk	8	25	SM	14.1	56.6	29.2		100	99	98	96	95	88	80	73	57	22
604	28	EX08P01a03	Bk1	25	43	SM	15.6	56.6	27.8		100	98	97	96	95	86	77	68	50	19
604	22	EX08P01a04	Bk2	43	64	SM	22.0	53.7	24.3		100	97	95	91	89	77	65	55	40	15
604	1	EX08P01a05	BCqk	64	90	SM	23.5	56.3	20.2		100	97	94	91	89	75	60	47	29	9

Batch	Sample	Field Sample Code	Horizon	Upper Depth (cm)	Lower Depth (cm)	USCS Group-Lab	Gravel_USCS (wt%)	Sand_USCS (wt%)	Silt+Clay_USCS (wt%)		P < 3-in	P < 2-in	P < 1 1/2-in	P < 1-in	P < 3/4-in	P < 3/8-in	P < #4	P < #10	P < #40	P < #200
702	10	ST02P01a01	A/AB	0	14	SM	10.5	59.0	30.5		100	99	98	97	96	91	87	82	70	27
702	37	ST02P01a02	2Bkb1	14	38	SM	13.4	59.6	27.0		100	99	98	97	97	89	81	72	57	20
702	6	ST02P01a03	2Bkb2	38	56	SM	18.0	60.2	21.8		100	98	97	95	94	84	73	61	44	15
702	8	ST02P01a04	2BCkb	56	71	SM	25.3	57.1	17.5		100	96	94	90	88	73	57	43	28	7
702	16	ST02P01a05	3Btkb	71	89	SM	14.0	55.6	30.4		100	99	98	97	96	86	77	53	41	17
702	31	ST02P01a06	3Bkmb	89	120	SM	21.7	54.3	24.0		100	96	93	90	87	76	64	52	40	12
702	5	ST02P01a07	3Bkb1	120	145	SM	12.4	67.3	20.3		100	99	99	98	97	90	83	73	52	13
702	2	ST02P01a08	3Bkb2/3	145	186	SM	25.1	57.2	17.7		100	94	90	84	79	69	60	53	39	9
702	26	ST02P01a09	3BCkb	186	204	SM	18.1	66.1	15.8		100	98	97	95	94	83	73	61	38	7
702	7	ST02P01a10	3B'tkb	204	217	SM	16.3	59.4	24.2		100	97	96	93	91	84	77	70	57	18
702	3	ST02P01a11	4Btkmb	217	240	SM	26.1	47.5	26.3		100	93	88	81	77	67	56	46	37	14
702	36	ST02P01a12	4Bkb1	240	261	SM	19.1	55.8	25.0		100	98	97	95	93	81	69	57	44	12
702	17	ST02P01a13	4Bkb2	261	275	SM	19.7	56.7	23.5		100	97	95	92	90	80	69	62	47	12
701	10	ST02P04a01	A1/A2	0	10	SM	10.8	48.6	40.7		100	100	99	99	99	93	86	82	72	37
701	2	ST02P04a02	Btk	10	22	SM	13.7	51.0	35.3		100	99	98	97	96	89	82	71	59	31
701	3	ST02P04a03	Bk	22	47	SM	21.1	57.5	21.3		100	95	92	87	84	77	69	60	43	15
701	20	ST02P04a04	BCk	47	85	SM	18.7	63.3	18.0		100	98	96	94	93	82	71	56	35	10
701	18	ST02P04a05	Ck1	85	166	SW-SM	32.3	57.8	9.9		100	94	89	83	79	62	43	31	17	4
701	12	ST02P04a06	Ck2	166	224	SM	3.2	69.8	27.0		100	100	100	100	99	98	96	93	78	24
701	5	ST02P04a07	2Bkb	224	239	SM	21.5	57.7	20.8		100	97	95	93	91	79	67	56	42	13
701	4	ST02P04a08	2BCkb	239	300	SW-SM	28.5	57.5	14.1		100	95	91	86	83	67	51	40	25	5
702	24	ST02P06a01	A1/A2	0	11	SM	6.5	60.8	32.7		100	100	99	99	99	96	92	84	66	29
702	34	ST02P06a02	AB/BA	11	30	SM	14.7	62.6	22.7		100	98	97	96	95	88	80	69	48	17
702	28	ST02P06a03	Bk1	30	62	SM	23.1	57.7	19.2		100	96	93	88	85	73	62	47	28	9

Batch	Sample	Field Sample Code	Horizon	Upper Depth (cm)	Lower Depth (cm)	USCS Group-Lab	Gravel_USCS (wt%)	Sand_USCS (wt%)	Silt+Clay_USCS (wt%)		P < 3-in	P < 2-in	P < 1 1/2-in	P < 1-in	P < 3/4-in	P < 3/8-in	P < #4	P < #10	P < #40	P < #200
702	12	ST02P06a04	Bk2	62	83	SM	15.6	63.0	21.4		100	97	95	92	90	84	79	72	53	15
702	30	ST02P06a05	BCk	83	121	SW-SM	7.5	78.0	14.5		100	100	100	100	100	95	90	78	47	9
701	17	ST03P01a01	Ap1/2	0	9	SM	3.0	64.5	32.5		100	100	100	100	99	98	97	92	77	31
701	9	ST03P01a02	Ap3	9	26	SM	4.0	55.8	40.2		100	100	100	100	100	98	95	92	80	38
701	14	ST03P01a03	BA	26	37	SM	2.7	61.6	35.8		100	100	100	100	100	99	97	90	75	35
701	15	ST03P01a04	Bk1	37	52	SM	2.7	65.1	32.2		100	100	100	100	100	99	97	92	76	32
701	8	ST03P01a05	Bk2	52	77	SM	2.0	66.3	31.7		100	100	100	100	100	99	98	93	76	31
701	16	ST03P01a06	BCk1	77	97	SM	4.2	74.0	21.7		100	100	100	100	100	98	95	90	73	22
701	22	ST03P01a07	BCk2	97	121	SW-SM	17.8	75.1	7.0		100	99	99	98	98	87	75	59	24	6
701	6	ST03P01a08	BC	121	189	ML	0.2	34.2	65.7		100	100	100	100	100	100	100	99	97	67
701	13	ST03P01a09	BAkb	189	214	ML	0.2	30.9	69.0		100	100	100	100	100	100	100	99	93	69
701	1	ST03P01a10	Bwb	214	232	SM	3.6	67.6	28.7		100	100	100	100	100	98	96	92	76	29
701	7	ST03P01a11	2Btkb	232	276	SM	7.8	64.7	27.5		100	100	100	100	100	96	91	83	66	27
701	19	ST03P01a12	2BCkb	276	296	SM	29.9	55.0	15.1		100	96	94	90	88	68	48	35	23	6
701	21	ST03P01a13	2Ckb	296	330	SW-SM	21.0	72.9	6.0		100	98	96	94	92	80	68	52	21	3
702	22	ST03P02a01	Ap1/2/3/4	0	19	SM	3.0	61.1	35.8		100	99	99	99	98	97	96	87	68	32
702	1	ST03P02a02	Ap5	19	39	SM	2.8	55.6	41.6		100	100	100	100	100	98	97	90	78	39
702	14	ST03P02a03	BA	39	54	SM	4.2	58.7	37.1		100	100	100	100	100	98	95	85	70	35
702	35	ST03P02a04	Bk1	54	74	SM	4.1	65.2	30.6		100	100	100	100	100	98	95	88	68	30
702	19	ST03P02a05	Bk2	74	95	SM	11.2	72.4	16.5		100	99	98	97	96	91	86	77	50	14
702	11	ST03P02a06	BCk1	95	117	SW-SM	25.2	67.9	6.9		100	98	96	93	92	77	61	48	24	5
702	23	ST03P02a07	BCk2	117	134	SW-SM	9.2	77.5	13.4		100	100	100	100	100	94	88	76	40	12
702	38	ST03P02a08	BCk3	134	163	SM	3.9	66.3	29.9		100	100	100	100	100	98	96	88	72	30
702	20	ST03P02a09	BCk4	163	176	SM	14.1	60.9	25.0		100	100	100	100	99	90	82	72	58	23

Batch	Sample	Field Sample Code	Horizon	Upper Depth (cm)	Lower Depth (cm)	USCS Group-Lab	Gravel_USCS (wt%)	Sand_USCS (wt%)	Silt+Clay_USCS (wt%)		P < 3-in	P < 2-in	P < 1 1/2-in	P < 1-in	P < 3/4-in	P < 3/8-in	P < #4	P < #10	P < #40	P < #200
702	4	ST03P02a10	BCk5	176	199	ML	0.1	34.0	65.8		100	100	100	100	100	100	100	100	98	67
702	13	ST03P02a11	BCk6	199	209	SM	3.9	72.0	24.0		100	100	100	100	100	98	96	91	68	24
702	33	ST03P02a12	BAkb	209	229	SM	1.6	54.2	44.2		100	100	100	100	100	99	98	92	75	43
702	21	ST03P02a13	Bkb	229	246	SM	2.5	70.5	27.0		100	100	100	100	100	99	97	92	63	26
702	32	ST03P02a14	BCkb	246	264	SW-SM	5.2	79.9	14.8		100	100	100	100	100	97	94	84	49	13
702	18	ST03P02a15	2Btkb	264	287	SM	6.6	67.8	25.7		100	100	100	99	99	96	92	85	64	25
702	29	ST03P02a16	2B'kb	287	301	SM	6.1	72.5	21.4		100	100	100	100	99	96	92	82	57	18
702	15	ST03P02a17	3Btkb	301	315	SM	3.8	68.6	27.6		100	100	100	100	100	98	95	83	59	22
702	25	ST03P02a18	3Bkb	315	330	SM	5.9	71.8	22.2		100	100	100	100	100	96	93	83	57	18
604	16	DBD (RM55G1)*	na	na	na	SM	34.1	44.6	21.3		100	99	98	97	96	71	46	46	38	15
702	9	DBD (RM55G1)*	na	na	na	SM	36.3	44.6	19.1		100	99	98	97	97	69	40	39	32	12
604	7	RM50F6	na	na	na	SM	21.9	57.0	21.1		100	99	99	98	98	82	67	51	42	15
701	11	RM50F6	na	na	na	SM	22.6	56.5	20.9		100	99	99	98	98	82	65	48	40	15
604	23	RM50F7	na	na	na	SM	20.7	56.8	22.4		100	99	99	98	98	83	69	51	42	17
702	27	RM50F7	na	na	na	SM	20.4	59.0	20.6		100	99	99	98	98	83	68	47	39	14

na=not applicable

* =Sample 410-01 in Lee and others,1996, DOE/NV/11718-073

APPENDIX E

NUMERICAL AGE DATA

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Samples for Carbon-14 (C14) and Optical Stimulated Luminescence (OSL) analyses were collected at the Area 3 RWMS from Soil Trench Three (ST03) on February 27, 1997, and September 27, 1997, respectively. Sample locations are shown on Figure E-1.

The C14 sample (Sample ST03Z2) consisted of several milligrams of charcoal that were separated from alluvium. The charcoal fragments were sent to Beta Analytic, Inc., for Accelerator Mass Spectrometry (AMS) analysis. Results of the C14 analysis are presented in the attached report from Beta Analytic Inc.

Optical Stimulated Luminescence samples consisted of alluvial and eolian deposits. Samples were collected using core tubes that were 1 in (2.54 cm) in diameter and 14 in (35.6 cm) long. Although the use of such a coring apparatus permits sample collection during daylight hours, samples were collected after twilight and were shielded by a black cloth to ensure that there was no exposure to sunlight. The samples were sent to the University of Utah Center for Applied Dosimetry for analysis (see attached report). Figure E-2 shows the numerical ages as a function volumetric water content.

The charcoal fragments (Sample ST03Z2) collected immediately adjacent to OSL Sample 2-2 (*Figure E-1*) yielded a conventional C14 numerical age of 10,530 ± 60 years before present. Figure E-3 is a synthesis of Late-Pleistocene, Holocene, and possible future climatic variations based on the work of Spaulding (1985). This figure shows an increase in temperature from a minimum during the last glacial stade to a hypsothermal during the early middle Holocene, natural cooling to the present-day temperature, a sharp hypothetical increase in temperature associated with "greenhouse" warming, followed by natural cooling toward a hypothetical glacial stade beyond 10,000 years hence. From about 11,000 to 10,000 years ago, summer precipitation may have been as much as 50 percent higher than at present, although annual amounts in the northern Mojave Desert probably were within 20 percent of current values. A volumetric water content of approximately 0.20 would yield an OSL numerical age that coincides with the C14 age. Based on previous studies (Spaulding, 1985), a volumetric water content in this range over the past 12,000 years is not unreasonable for the deposits where the OSL samples were obtained.

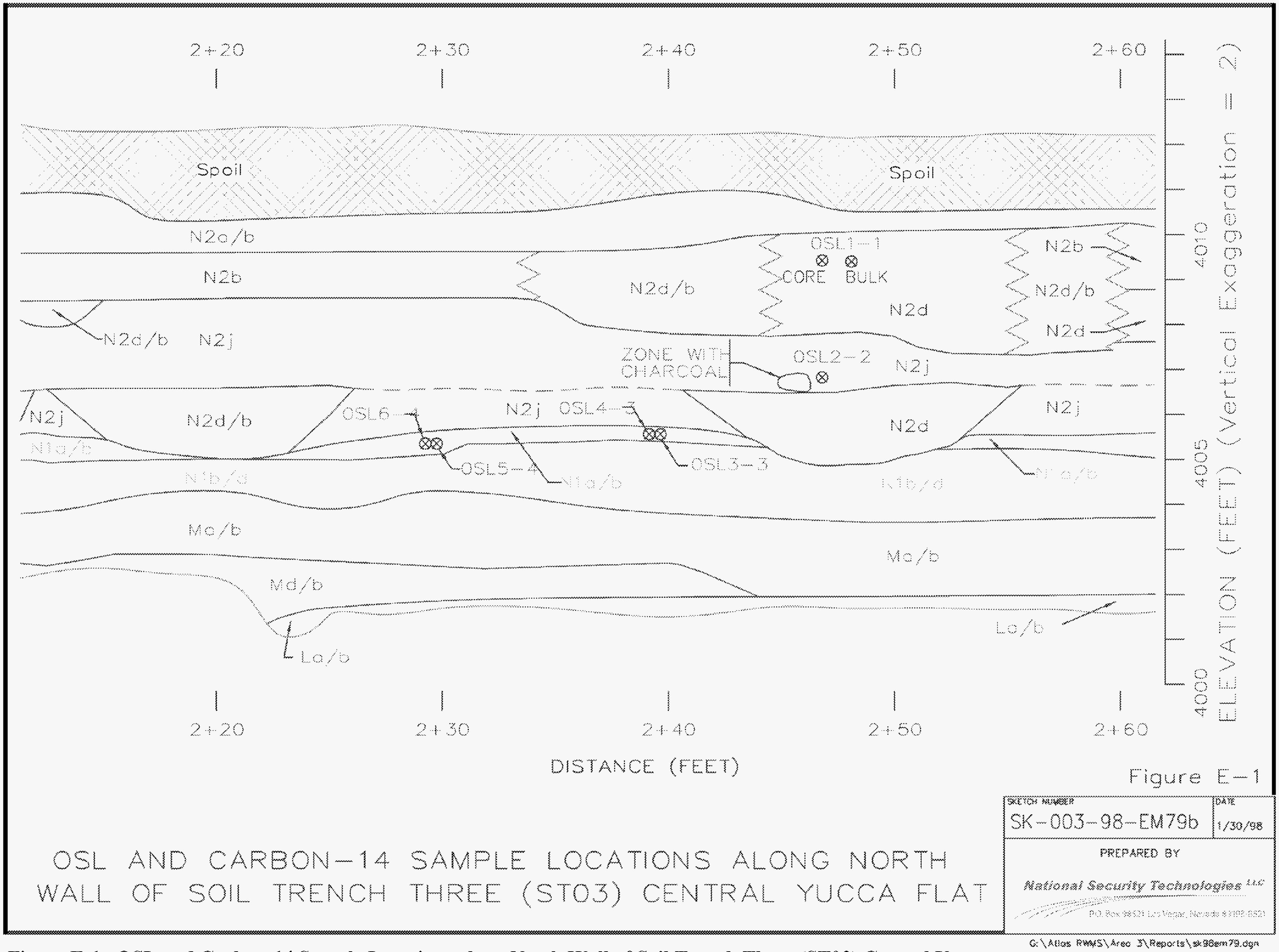

Figure E-1. OSL and Carbon-14 Sample Locations along North Wall of Soil Trench Three (ST03) Central Yucca

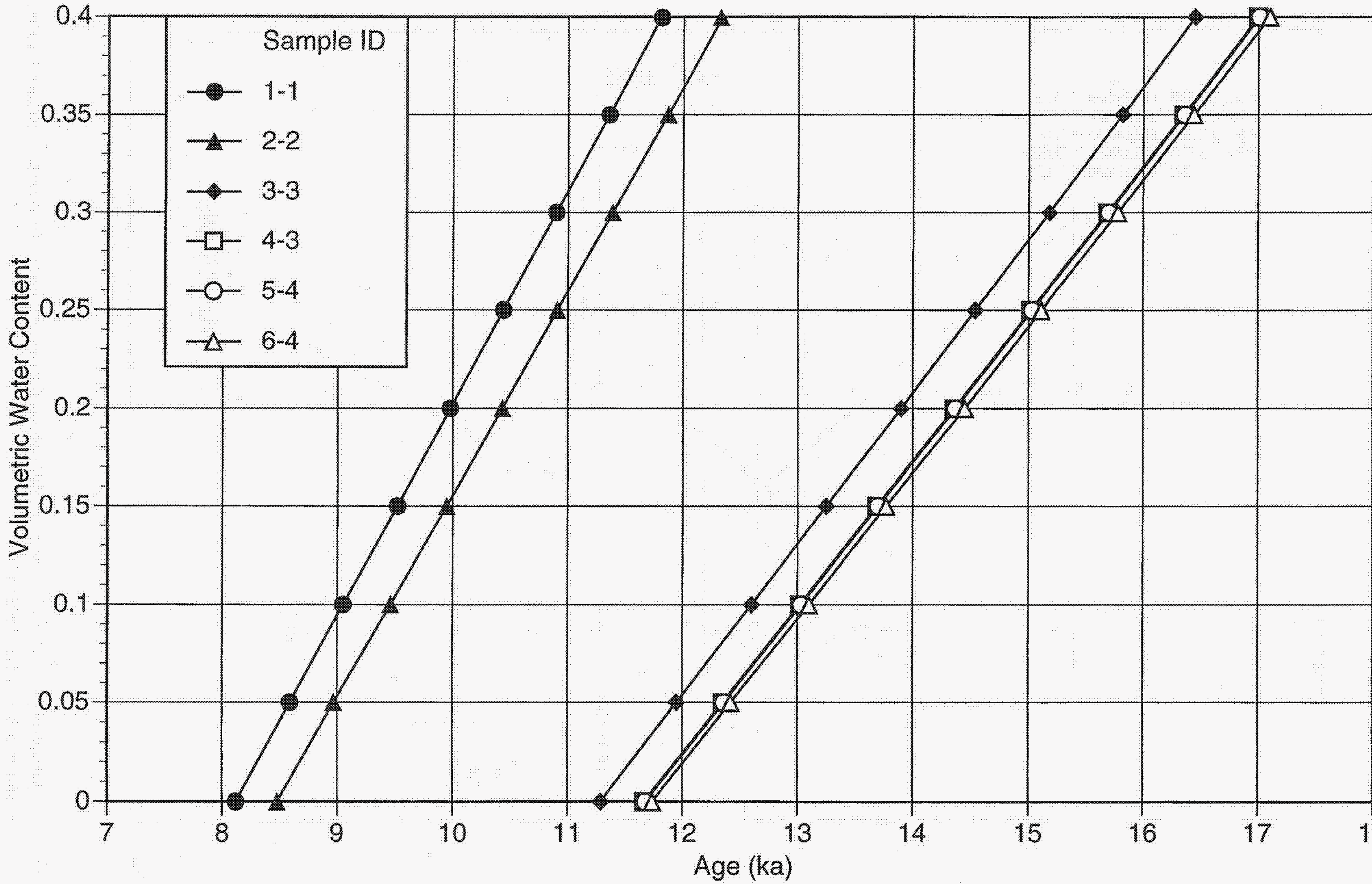

Figure E-2 **Plot of Volumetric Water Content versus OSL Numerical Ages**

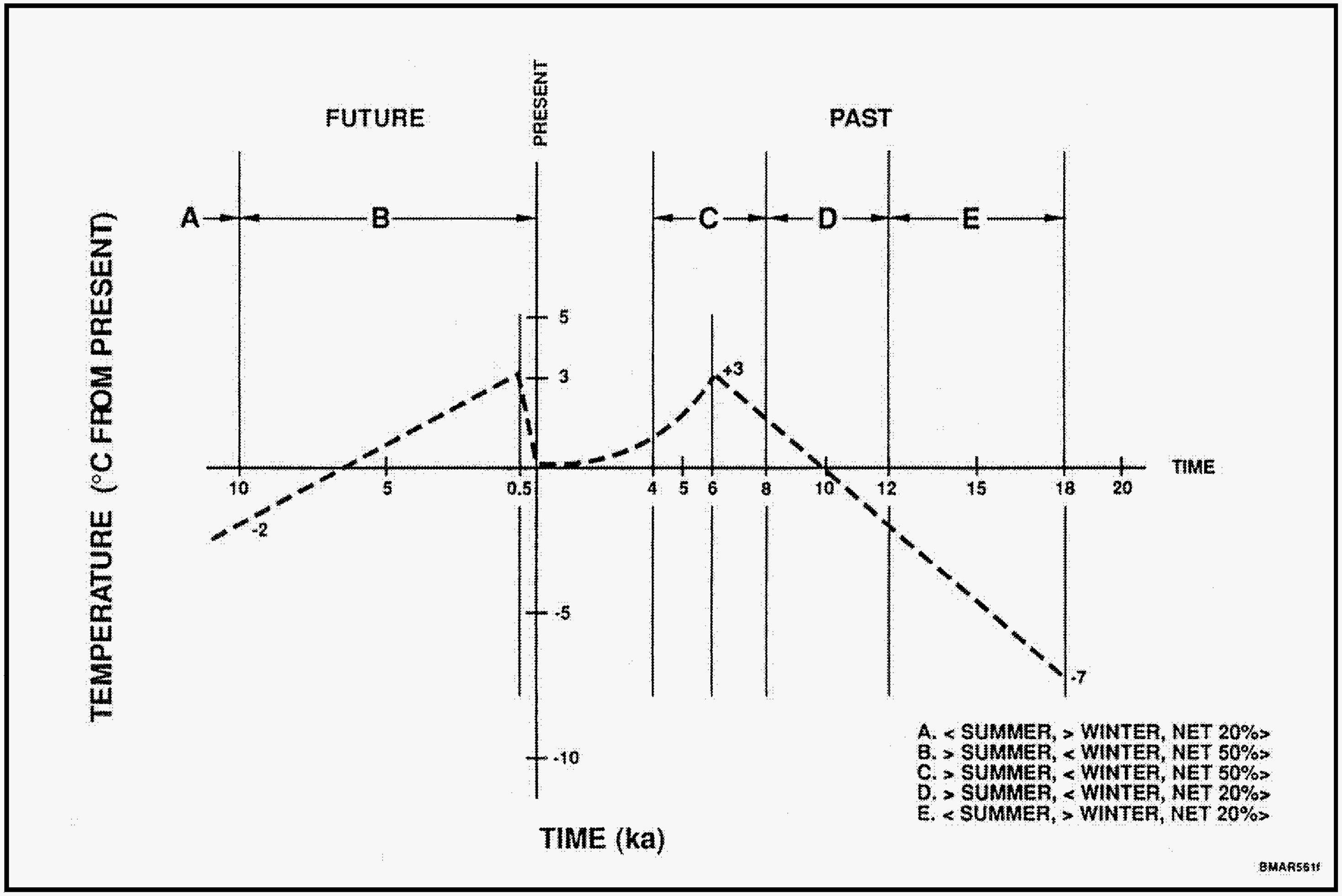

Figure E-3 Synthesis of Late-Pleistocene, Holocene, and Possible Future Climatic Variations Based on the Work of Spaulding (1985)

BETA ANALYTIC INC.

RADIOCARBON DATING SERVICES

Dr. MURRY A. TAMERS
Mr. DARDEN G. HOOD
Directors

RONALD E. HATFIELD
Laboratory Manager

CHRISTOPHER PATRICK
TERESA A. ZILKO-MILLER
Associate Managers

September 8, 1997

Bectel Nevada
P.O. Box 98521
Las Vegas, NV 89193

Please find enclosed the radiocarbon dating results for one charcoal sample (STO3Z2) which was submitted on August 21. The sample was very small and was analyzed by the AMS method, on the ADVANCE basis. Pretreatment, C14 content measurement and age calculation went normally. The quoted errors represent 1 sigma statistics. Since these errors cannot include uncertainties outside of those which can be quantified during measurement, it is best to consider them as minimum quotes.

Literature discussing the generalities of analysis and calendar calibration are enclosed. The "Analytical Procedures and Final Report" discussion should answer most questions about the report and results. If you have any specific questions, please do not hesitate to contact us.

The cost of the analysis was charged to your VISA card. A receipt is enclosed. Thank you.

Sincerely,

Darden Hood

4985 S.W. 74 COURT, MIAMI, FL 33155 U.S.A.
TELEPHONE: 305-667-5167 / FAX: 305-663-0964 / INTERNET: beta@radiocarbon.com
WEB SITE: http://www.radiocarbon.com

BETA ANALYTIC INC.

DR. M.A. TAMERS and MR. D.G. HOOD

UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964
E-MAIL: beta@radiocarbon.com

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Bectel Nevada

DATE RECEIVED: August 21, 1997

DATE REPORTED: September 8, 1997

Sample Data	Measured C14 Age	C13/C12 Ratio	Conventional C14 Age (*)
Beta-108347	10550 +/- 60 BP	-26.2 o/oo	10530 +/- 60 BP

SAMPLE #: ST03Z2
ANALYSIS: ADVANCE AMS (LLNL)
MATERIAL/PRETREATMENT:(charred material): acid/alkali/acid

Dates are reported as RCYBP (radiocarbon years before present, "present" = 1950A.D.). By International convention, the modern reference standard was 95% of the C14 content of the National Bureau of Standards' Oxalic Acid & calculated using the Libby C14 half life (5568 years). Quoted errors represent 1 standard deviation statistics (68% probability) & are based on combined measurements of the sample, background, and modern reference standards.

Measured C13/C12 ratios were calculated relative to the PDB-1 international standard and the RCYBP ages were normalized to -25 per mil. If the ratio and age are accompanied by an (*), then the C13/C12 value was estimated, based on values typical of the material type. The quoted results are NOT calibrated to calendar years. Calibration to calendar years should be calculated using the Conventional C14 age.

BETA ANALYTIC INC.
RADIOCARBON DATING LABORATORY
CALIBRATED C-14 DATING RESULTS

Calibrations of radiocarbon age determinations are applied to convert BP results to calendar years. The short term difference between the two is caused by fluctuations in the heliomagnetic modulation of the galactic cosmic radiation and, recently, large scale burning of fossil fuels and nuclear devices testing. Geomagnetic variations are the probable cause of longer term differences.

The parameters used for the corrections have been obtained through precise analyses of hundreds of samples taken from known-age tree rings of oak, sequoia, and fir up to 7,200 BP. The parameters for older samples, up to 22,000 BP, as well as for all marine samples, have been inferred from other evidence. Calibrations are presently provided for terrestrial samples to about 10,000 BP and marine samples to about 8,300 BP.

The Pretoria Calibration Procedure program has been chosen for these dendrocalibrations. It uses splines through the tree-ring data as calibration curves, which eliminates a large part of the statistical scatter of the actual data points. The spline calibration allows adjustment of the average curve by a quantified closeness-of-fit parameter to the measured data points. On the following calibration curves, the solid bars represent one sigma statistics (68% probability) and the hollow bars represent two sigma statistics (95% probability). Marine carbonate samples that have been corrected for $\delta^{13/12}C$, have also been corrected for both global and local geographic reservoir effects (as published in Radiocarbon, Volume 35, Number 1, 1993) prior to the calibration. Marine carbonates that have not been corrected for $\delta^{13/12}C$, have been adjusted by an assumed value of 0 ‰ in addition to the reservoir corrections. Reservoir corrections for fresh water carbonates are usually unknown and are generally not accounted for in those calibrations. In the absence of measured $\delta^{13/12}C$ ratios, a typical value of -5 ‰ was assumed for freshwater carbonates. There are separate calibration data for the Northern and Southern Hemisphere. Variables used in each calibration are listed below the title of each calibration page.

(Caveat: the calibrations assume that the material dated was living for exactly ten or twenty years (e.g. a collection of 10 or 20 individual tree rings taken from the outer portion of a tree that was cut down to produce the sample in the feature dated). For other materials, the maximum and minimum calibrated age ranges given by the computer program are uncertain. The possibility of an "old wood effect" must also be considered, as well as the potential inclusion of some younger material in the total sample. Since the vast majority of samples dated probably will not fulfill the ten/twenty-year-criterium and, in addition, an old wood effect or young carbon inclusion might not be excludable, these dendrocalibration results should be used only for illustrative purposes. In the case of carbonates, reservoir correction is theoretical and the local variations are real, highly variable and dependant on provenience. The age ranges and, especially, the intercept ages generated by the program must be considered as approximations.)

Report on OSL Dating of Quartz Sands From Soil Trench Three (ST03)
Southern Yucca Flat, Nevada.

E.H. Haskell

University of Utah, Center for Applied Dosimetry, 729 Arapeen Dr. Salt Lake City, UT 84108

Nine samples which had been taken from Soil Trench Three (ST03) Southern Yucca Flat, Nevada were received by the Center for Applied Dosimetry. Six of the samples, 1-1, 2-2, 3-3, 4-3, 5-4 and 6-4 were supplied for Optically Stimulated Luminescence (OSL) dating; three others, 1B, 2B, 3b and 4B were collected for gamma ray spectroscopy measurements. OSL sands averaged approximately 200g while bulk sands averaged .5kg.

Materials and Methods

Gamma ray spectrometry measurements were carried out on the bulk samples according to the method of Lloyd (1976) with each sample placed between two 8-inch (20-cm) NaI detectors. Conversion from activities to dose rates was as described by Aitken (1985) as was attenuation due to water content and beta attenuation as a function of grain size.

Cosmic ray dose rates were calculated using the method of Prescott and Stephan (1982) considering latitude, longitude and sample depth.

Samples were sieved into grain size fractions of 75 to 106 μm and treated in concentrated (37%) HCL in an ultrasonic bath at 55°C for 40 minutes and then rinsed three times in distilled water in an ultrasonic bath for 60 seconds. The samples were then etched in concentrated (48%) HF for 30 minutes while stirring at room temperature and then rinsed in distilled water as above followed by treatment in concentrated HCL for 5 minutes at 55°C in an ultrasonic bath. Following HCL treatment samples were rinsed three times in distilled water in an ultrasonic bath for 60 seconds each. Sodium polytungstate heavy liquid (SOMETU-US 5659 Nobel Ave. Van Nuys, CA 91411) was used for speparation of quartz from the heavy mineral fractions.

Quartz measurements were carried out on a Daybreak/Utah 100 TL reader (Custom-manufactured to University of Utah specifications by Daybreak Nuclear and Medical Systems, Inc, 50 Denison Drive, Guilford, CT 06437) equipped with a 9635QA photomultiplier tube, a trifrucated fiber optic input and on-plate beta irradiation from a 0.21 Gy s^{-1} 60 mCi Sr-90/Y-90 beta source (Isotope Products Laboratories, 1800 North Keystone St., Burbank California, 91504.). Measurements were made using 514.5 nm

(2.41eV) stimulation from an Ar-ion laser (Model 909, American Laser, 1832 S. 3850 W. Salt Lake City, UT) with four 7-59 filters (Corning glasses, available from Kopp Glass Inc, 2108 Palmer Street, Pittsburgh, PA 15218) and one UG11 filter (Schott glass, available from Schott Glass Technologies Inc., 400 York Ave., Duryea, PA 18642)in front of the photomultiplier tube. Laser input was filtered with a narrow (1nm) band-pass filter (Filter # D1-515F, Corion Corporation, 73 Jeffrey Ave. Holliston, MA 01746-2082).

Samples were analyzed using an OSL measurement protocol similar to that developed by Murray and Roberts (M. Aitken, Presonal communication).

The underlying principle of the OSL technique used lies in the fact that OSL of quartz can undergo significant changes in sensitivity with repeated readout. These changes complicate single aliquote dating methods because of heat induced changes in the population of luminescence centers. Repeated application and readout of the same dose of radiation may result in the same number of electrons being trapped with each cycle, however, readout of the signal during trap emptying will result in different signal intensities depending on the number of luminescence centers available for recombination with the released electrons. The change in luminescent center population in quartz results from the sample pre-heating required to empty low stability traps. Since the population of luminescence centers responsible for emission from the 110°C TL peak of quartz is the same population responsible for emission with OSL, the 110°C TL peak can be used as monitor for the sensitivity of the OSL signal.

If no change in sensitivity of a sample occurs during readout, the ratio of the readout of the initial OSL due to accumulation of the paleodose will be proportion to the OSL obtained from shine-down of a subsequent regenerative dose. If the two readouts are identical (and assuming no change in sensitivity) then the paleodose is equal to the regenerative dose (also assuming that shallow traps have been emptied similarly in both shine-downs). Unfortunately there is usually a change in sensitivity between each shine-down for reasons given above. To correct for this change in sensitivity we used the following analytical procedure. For our measurements, TL output at 100°C was normalized to the initial TL readout of the first cycle obtained in step 4, below. All subsequent TL measurements were normalized to this initial value. All OSL measurements were likewise normalized to the values of the first OSL shine-down in step 2. Since the first TL measurement is taken after the first shine-down, with no interposing preheat treatments, the luminescence center population for both of these should be identical. The relative center population at the initial shine-down is known from this measurement of TL output, and the relative center population for the shine-down of each regenerative dose is obtained by measuring subsequent TL output from the 110°C TL peak. By plotting the relative OSL output versus the relative TL output for each regenerative shine-down, and then extrapolating back to the OSL intercept where the TL value is equal to 1, a scaling factor can be obtained for correcting for sensitivity change between the initial OSL shine-down of the paleodose and the following shine-down of the regenerative dose. The paleodose is determined as follows:

$D = A * R/S$

where

A = the laboratory applied dose (Gy)
R = the ratio of the OSL output from the paleodose to that from the laboratory applied dose,

S = the scaling factor determined as described above.

The measurement steps are as follows:

(1) preheat for 10 seconds at 290°C ;

(2) shine-down at 120°C to measure (and remove) the OSL;

(3) administer regenerative dose using a value near to the expected paleodose;

(4) preheat again, measuring the 110°C TL peak as the temperaure rises;

(5) continue from step 2 for a total of 5 cycles, using the same regenerative dose in each cycle. The natural OSL is measured in the first step 2, and regenerated OSL in step 2 of subsequent cycles.

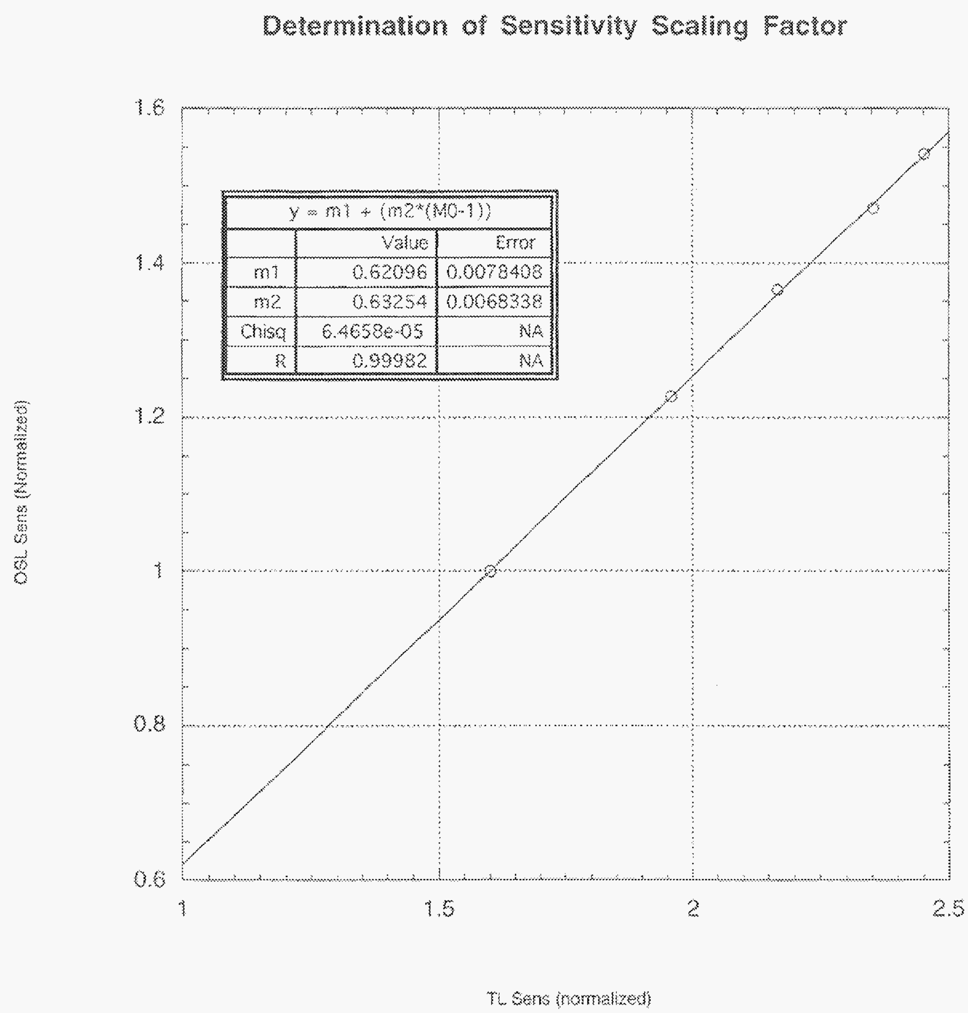

Figure E-4. Determination of sensitivity scaling factor. Scaling factor S is the normalized OSL value for the intercept at TL = 1 (Example from Sample 6-4)

Results:

Background dose rates:

Code	Ac-228	±	K-40	±	Rn-222	±	Th-228	±
1B	1.445	0.035	24.355	0.785	1.315	0.049	1.470	0.014
2B	1.490	0.057	20.615	0.389	1.345	0.021	1.450	0.014
3B	1.505	0.042	21.350	0.016	1.360	0.021	1.530	0.009
4B	1.475	0.043	20.675	0.026	1.330	0.021	1.490	0.019

Table E-1. Gamma ray spectrometry results are shown in Table 1 for bulk samples. Each value is the mean of two separate measurements. Values are in PCi/g.

Lat	Long	Elev (km)	Depth (m)	Ef. Dens	Geo. Mag. Lat.	Soft (mGy/ka)	Hard (mGy/ka)	Tot (mGy/ka)	Samp.
37	-116	1.2	0.0	1.45	44	110	232	342	
37	-116	1.2	0.1	1.45	44	75	229	304	
37	-116	1.2	0.2	1.45	44	49	226	275	
37	-116	1.2	0.3	1.45	44	30	223	253	
37	-116	1.2	0.4	1.45	44	18	220	238	
37	-116	1.2	0.5	1.45	44	9	217	227	
37	-116	1.2	0.6	1.45	44	4	215	219	
37	-116	1.2	0.7	1.45	44	1	212	213	
37	-116	1.2	0.8	1.45	44	0	209	209	1-1
37	-116	1.2	0.9	1.45	44	0	207	206	
37	-116	1.2	1.0	1.45	44	0	204	203	
37	-116	1.2	1.1	1.45	44	0	201	201	
37	-116	1.2	1.2	1.45	44	0	199	199	
37	-116	1.2	1.3	1.45	44	0	196	196	
37	-116	1.2	1.4	1.45	44	0	194	194	
37	-116	1.2	1.5	1.45	44	0	191	191	2-2
37	-116	1.2	1.6	1.45	44	0	189	189	
37	-116	1.2	1.7	1.45	44	0	186	186	
37	-116	1.2	1.8	1.45	44	0	184	184	
37	-116	1.2	1.9	1.45	44	0	182	182	
37	-116	1.2	2.0	1.45	44	0	179	179	3-3,4-3
37	-116	1.2	2.1	1.45	44	0	177	177	5-4,6-4
37	-116	1.2	2.2	1.45	44	0	175	175	
37	-116	1.2	2.3	1.45	44	0	172	172	
37	-116	1.2	2.4	1.45	44	0	170	170	
37	-116	1.2	2.5	1.45	44	0	168	168	
37	-116	1.2	2.6	1.45	44	0	166	166	
37	-116	1.2	2.7	1.45	44	0	164	164	
37	-116	1.2	2.8	1.45	44	0	162	162	
37	-116	1.2	2.9	1.45	44	0	160	160	
37	-116	1.2	3.0	1.45	44	0	158	158	

Table E-2. Cosmic ray dose-rate as function of sample depth. Samples are indicated at their appropriate depths in the last column.

Sample Code	Beta	±	Beta w atten	±	Gamma	±	Beta + Gamma	±
BN STO3 1B	3.3	0.020	3.1	0.019	1.8	0.015	4.92	0.024
BN STO3 1B	3.4	0.021	3.2	0.020	1.8	0.017	4.98	0.026
BN STO3 2B	3.0	0.025	2.8	0.024	1.7	0.020	4.51	0.031
BN STO3 2B	3.0	0.025	2.8	0.024	1.7	0.020	4.53	0.031
BN STO3 3B	3.0	0.021	2.9	0.020	1.8	0.017	4.64	0.026
BN STO3 3B	3.1	0.021	2.9	0.021	1.8	0.017	4.68	0.027
BN STO3 4B	3.0	0.022	2.8	0.021	1.7	0.018	4.52	0.028
BN STO3 4B	3.0	0.023	2.8	0.022	1.7	0.019	4.53	0.029

Table E-3. Beta and Gamma dose-rates (Gy/ka) for water content = 0.0 and beta attenuation due to finite grain size.

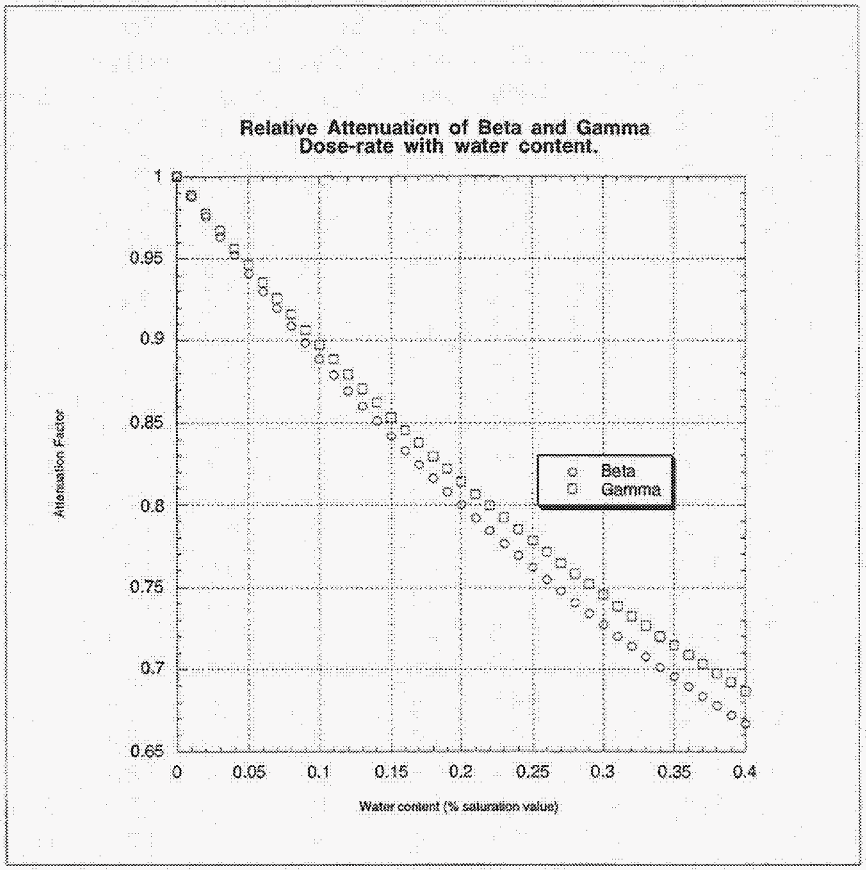

Figure E-5. Relative attenuation of beta and gamma dose-rates with increasing water content.

OSL results

	1 - 1	S.E.	2 - 2	S.E.	3 - 3	S.E.	4 - 3	S.E.	5 - 4	S.E.	6 - 4	S.E.
Wtd	38.4	0.1	41.6	0.8	54.6	0.9	55.4	0.0	57.7	0.8	53.5	0.5
Unwtd	46.0	2.1	38.3	1.9	52.9	2.3	55.7	2.4	53.5	1.4	60.6	2.4
Wtd,Unwtd	42.2	3.8	40.0	1.6	53.8	0.8	55.6	0.2	55.6	2.1	57.0	3.6
n	12		12		16		16		16		20	
Outliers (Wtd)	0		0		0		0		0		0	
Outliers (Unwtd)	0		1		1		2		1		1	

Table E-4. Paleodose values (Gy). Weighted values are obtained by weighting individual dose measurements (D) in Table ( ) by the square of their propogated uncertainty (sD).

Wtd	55.3	1.8
Unwtd	55.7	3.5
Wtd,Unwtd	55.5	1.3

Table E-5. Mean results of the Paleodose measurements for samples 3-3, 4-3, 5-4, and 6-4 all taken from the same layer of Aeolian sand. The decision to use the average of the unweighted and the weighted means of each sample as the "best estimate" of Paleodose was based on an analysis of the uncertainties in the four samples taken from the same layer. As seen in this figure, uncertainty associated with the average of the weighted and unweighted means (±1.3) is lower than either that of the weighted mean (±3.5)

Results of OSL dose analysis for each individual sample.

In the tables below, the OSL measurement of dose D (Gy) is determined as follows.

$D = A * R/S$
where

A = the laboratory applied dose (Gy),
R = the ratio of the OSL output from the paleodose to that from the laboratory applied dose,
S = the scaling factor described in the text.
sS = the standard error in the scaling factor
sD = the standard error in the dose estimate obtained by propogation of sS

1 - 1					
A	R	S	sS	D	sD
56.7	0.872	0.8336	0.1721	59.3	12.2
56.7	0.888	0.9330	0.0454	54.0	2.6
56.7	0.668	1.0798	0.0191	35.1	0.6
56.7	0.765	0.9710	0.0154	44.7	0.7
44.1	0.933	0.8556	0.0558	48.1	3.1
44.1	0.932	0.8420	0.0808	48.8	4.7
44.1	1.032	0.8998	0.0126	50.6	0.7
44.1	0.764	0.9962	0.0107	33.8	0.4
44.1	0.871	0.8683	0.0393	44.2	2.0
44.1	0.707	0.7001	0.0976	44.5	6.2
44.1	0.893	0.8547	0.0691	46.1	3.7
44.1	0.759	0.7884	0.0804	42.5	4.3

Table E-6. Paleodose values for individual measurements of Sample 1-1.

2 - 2					
A	R	S	sS	D	sD
38.9	0.774	0.5998	0.0708	50.1	5.9
38.9	0.891	0.4301	0.1067	80.4	20.0
38.9	0.731	0.7290	0.0879	39.0	4.7
38.9	0.769	0.7279	0.0455	41.0	2.6
42.0	0.711	0.7592	0.0866	39.3	4.5
42.0	0.572	0.7947	0.1513	30.2	5.8
42.0	0.900	0.8717	0.0188	43.4	0.9
42.0	0.610	0.8143	0.0997	31.5	3.9
42.0	0.903	0.8744	0.0704	43.4	3.5
42.0	0.629	0.6779	0.1077	39.0	6.2
42.0	0.534	0.7155	0.1463	31.4	6.4
42.0	0.550	0.6872	0.0606	33.6	3.0

Table E-7. Paleodose values for individual measurements of Sample 2-2. The 80.4 Gy value was removed for the unweighted mean

3 - 3					
A	R	S	sS	D	sD
34.7	1.008	0.9243	0.3209	37.8	13.1
34.7	0.959	0.8554	0.0857	38.8	3.9
34.7	1.030	0.7792	0.0463	45.8	2.7
34.7	1.098	0.1738	0.2580	218.9	324.8
52.5	1.013	0.8264	0.0225	64.3	1.8
52.5	0.839	0.8720	0.0863	50.5	5.0
52.5	0.841	0.9329	0.4435	47.4	22.5
52.5	0.815	0.7069	0.3237	60.6	27.7
56.7	0.823	0.7947	0.2451	58.7	18.1
56.7	0.820	0.9538	0.1802	48.8	9.2
56.7	0.767	0.8117	0.1024	53.6	6.8
56.7	0.882	0.7099	0.1973	70.4	19.6
56.7	0.715	0.8128	0.0358	49.9	2.2
56.7	0.621	0.6104	0.0354	57.7	3.3
56.7	0.675	0.6927	0.0318	55.3	2.5
56.7	0.643	0.6668	0.0322	54.7	2.6

Table E-8. Paleodose values for individual measurements of Sample 3-3. The 218.9 Gy value was removed for the unweighted mean

4 - 3					
A	R	S	sS	D	sD
44.1	0.829	0.7419	0.0509	49.3	3.4
44.1	0.813	0.7752	0.1539	46.2	9.2
44.1	0.737	0.6162	0.1244	52.8	10.7
44.1	0.758	0.6416	0.1011	52.1	8.2
50.4	0.909	0.6402	0.1491	71.6	16.7
50.4	0.933	1.0419	0.1578	45.1	6.8
50.4	0.736	0.4325	0.1931	85.7	38.3
50.4	0.812	0.6750	0.0678	60.7	6.1
55.7	0.687	0.8116	0.1102	47.1	6.4
55.7	0.942	0.8572	0.1509	61.2	10.8
55.7	0.826	0.6173	0.2705	74.5	32.6
55.7	0.774	0.6934	0.0307	62.1	2.7
55.7	0.825	0.4097	0.2345	112.1	64.2
55.7	0.745	0.7972	0.1421	52.0	9.3
55.7	0.660	0.7284	0.1942	50.4	13.4
55.7	0.683	0.6873	0.1014	55.3	8.2

Table E-9. Paleodose values for individual measurements of Sample 4-3. The 85.7 Gy and 112.1 Gy values were removed for the unweighted mean

5 - 4					
A	R	S	sS	D	sD
55.7	0.741	0.6676	0.0107	61.8	1.0
55.7	0.735	0.7359	0.0859	55.6	6.5
55.7	0.800	0.4405	0.3063	101.1	70.3
55.7	0.593	0.5785	0.1638	57.0	16.1
68.3	0.588	0.6912	0.0954	58.0	8.0
68.3	0.599	0.8040	0.0360	50.8	2.3
68.3	0.683	0.9226	0.1139	50.5	6.2
68.3	0.607	0.7994	0.1268	51.8	8.2
52.5	0.862	0.7896	0.1285	57.3	9.3
52.5	0.624	0.7923	0.0778	41.4	4.1
52.5	0.742	0.6537	0.1106	59.6	10.1
52.5	0.778	0.8216	0.1009	49.7	6.1
52.5	0.703	0.7792	0.0757	47.4	4.6
52.5	0.791	0.7433	0.1027	55.9	7.7
52.5	0.848	0.8179	0.1401	54.5	9.3
52.5	0.834	0.8658	0.0560	50.6	3.3

Table E-10. Paleodose values for individual measurements of Sample 5-4. The 101.1 Gy value was removed for the unweighted mean

6-4					
A	R	S	sS	D	sD
52.5	1.077	0.8844	0.1629	63.9	11.8
52.5	0.904	0.9930	0.0693	47.8	3.3
52.5	0.832	0.8428	0.0130	51.8	0.8
52.5	0.811	0.9213	0.0615	46.2	3.1
48.3	0.834	0.8789	0.1509	45.8	7.9
48.3	0.742	0.5731	0.1394	62.6	15.2
48.3	0.795	0.7456	0.0203	51.5	1.4
48.3	0.702	0.6210	0.0078	54.6	0.7
56.7	0.662	0.4914	0.1867	76.3	29.0
56.7	0.897	0.9007	0.0918	56.5	5.8
56.7	0.681	0.5171	0.0934	74.6	13.5
56.7	0.971	0.9193	0.1007	59.9	6.6
56.7	0.789	0.9189	0.0448	48.7	2.4
56.7	0.790	0.6282	0.0756	71.3	8.6
56.7	1.008	0.9033	0.0514	63.3	3.6
56.7	0.785	0.7458	0.2052	59.7	16.4
60.5	0.760	0.5909	0.2075	77.8	27.3
60.5	0.906	0.6085	0.1813	90.0	26.8
60.5	0.849	0.7750	0.0627	66.3	5.4
60.5	0.705	0.5835	0.0304	73.1	3.8

Table E-11. Paleodose values for individual measurements of Sample 6-4. The 90.0 Gy value was removed for the unweighted mean

Age as function of water content (Avg of Wtd and Mean values)						
H20	1-1	2-2	3-3	4-3	5-4	6-4
0.00	8.18	8.48	11.29	11.67	11.68	11.97
0.01	8.27	8.58	11.43	11.81	11.81	12.11
0.02	8.36	8.68	11.56	11.95	11.95	12.25
0.03	8.46	8.78	11.69	12.08	12.08	12.39
0.04	8.55	8.88	11.82	12.21	12.22	12.53
0.05	8.65	8.97	11.95	12.35	12.36	12.67
0.06	8.74	9.07	12.08	12.49	12.49	12.81
0.07	8.84	9.17	12.21	12.62	12.62	12.94
0.08	8.93	9.27	12.34	12.76	12.76	13.08
0.09	9.02	9.36	12.47	12.89	12.89	13.22
0.10	9.12	9.46	12.60	13.02	13.03	13.36
0.11	9.21	9.56	12.73	13.16	13.16	13.49
0.12	9.31	9.66	12.86	13.29	13.30	13.63
0.13	9.40	9.75	12.99	13.43	13.43	13.77
0.14	9.49	9.85	13.12	13.56	13.57	13.91
0.15	9.59	9.95	13.25	13.69	13.70	14.04
0.16	9.68	10.05	13.38	13.83	13.83	14.18
0.17	9.77	10.14	13.51	13.96	13.97	14.32
0.18	9.87	10.24	13.64	14.10	14.10	14.46
0.19	9.96	10.34	13.77	14.23	14.24	14.59
0.20	10.05	10.43	13.90	14.36	14.37	14.73
0.21	10.15	10.53	14.02	14.49	14.50	14.87
0.22	10.24	10.62	14.15	14.63	14.63	15.00
0.23	10.33	10.72	14.28	14.76	14.77	15.14
0.24	10.42	10.82	14.41	14.89	14.90	15.28
0.25	10.52	10.91	14.54	15.02	15.03	15.41
0.26	10.61	11.01	14.67	15.16	15.17	15.55
0.27	10.70	11.10	14.79	15.29	15.30	15.68
0.28	10.79	11.20	14.92	15.42	15.43	15.82
0.29	10.89	11.29	15.05	15.55	15.56	15.96
0.30	10.98	11.39	15.18	15.69	15.70	16.09
0.31	11.07	11.49	15.31	15.82	15.83	16.23
0.32	11.16	11.58	15.44	15.95	15.96	16.36
0.33	11.25	11.68	15.56	16.08	16.09	16.50
0.34	11.35	11.77	15.69	16.21	16.22	16.63
0.35	11.44	11.87	15.82	16.35	16.36	16.77
0.36	11.53	11.96	15.94	16.48	16.49	16.90
0.37	11.62	12.06	16.07	16.61	16.62	17.04
0.38	11.71	12.15	16.20	16.74	16.75	17.17
0.39	11.81	12.25	16.32	16.87	16.88	17.30
0.40	11.90	12.34	16.45	17.00	17.01	17.44

Table E-12. Age estimates (ka) as function of water content for all samples

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